12-2020

WOMEN IN BEEKEEPING: IMPACTS OF A BEEKEEPER EDUCATIONAL PROGRAM

Bridget Gross
University of Nebraska-Lincoln

WOMEN IN BEEKEEPING: IMPACTS OF A BEEKEEPER EDUCATIONAL PROGRAM

by

Bridget A. Gross

A THESIS

Presented to the Faculty of

The Graduate College of the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Master of Science

Major: Entomology

Under the Supervision of Professors Doug Golick and Judy Wu-Smart

Lincoln, Nebraska

December, 2020

WOMEN IN BEEKEEPING: IMPACTS OF A BEEKEEPER EDUCATIONAL PROGRAM

Bridget A. Gross, M.S.

University of Nebraska, 2020

Advisors: Douglas Golick, Judy Wu-Smart

The decline in honey bee populations over the past two decades in the United States is alarming. The management provided by beekeepers to their honey bee colonies influences the survival of the colony. However, there is a lack of information on the experiences of beekeepers, specifically women beekeepers. The Center for Rural Affairs (CFRA) in Nebraska hosted the "Honey Bees on the Farm: Connecting Women Beekeepers and Women Farmers for Environmental and Economic Benefit" program that provided informal, educational events to women beekeepers and landowners. Using a convergent mixed methods design, the first research question examines the impacts of the Women in Beekeeping program on participant's knowledge, self-efficacy, management, and colony health. Nine beekeepers from the Women in Beekeeping program participated in a series of surveys, interviews, and video-recorded hive inspections to measure the program's impacts. Participant knowledge and management did not significantly increase after participating in the program. Participant self-efficacy improved after participating in the program. Colony health significantly improved from May to July while participants were involved in the program. Compared to beekeepers not in the program, those who were in the program were more knowledgeable about general pollination

knowledge and had different views regarding colony health. Both populations were similar in terms of self-efficacy and management.

The second research question examines the experiences of twelve women beekeepers. I used a transcendental phenomenological approach to focus on the lived experiences of the women beekeepers. Women reported generally positive experiences with the local beekeeping community, and connected their beekeeping experiences to their experiences with motherhood and family. Additionally, beekeeper's values played a role in how they managed their hives and their experiences beekeeping. Overall, beekeeper educational programming should continue to provide hands-on informal programs, but more research is needed to fully understand the impacts of these programs.

Acknowledgments

This research would not have been possible without the dedication of my research participants. I cannot thank them enough for their time, generosity, and willingness to share their knowledge with me. Their enthusiasm for beekeeping was contagious, and continuously inspires me. I thoroughly enjoyed working with them throughout this project. Without them, this research would not have been possible, nor would this research project have been as enjoyable.

Thanks to my wonderful advisors: Dr. Doug Golick and Dr. Judy Wu-Smart. Judy, thank you for introducing me to UNL and continuing to educate me on honey bees. Doug, thank you for your guidance, breadth of knowledge, and unwavering moral support over the past two years. I would also like to thank my committee members: Dr. Jenny Dauer and Dr. Louis Lynch-O'Brien for their support and guidance throughout this project. They have helped guide me in research design and execution since the beginning. Additional thanks to my family for their support throughout my education. Special thanks to Kelsey Karnik in the Statistics Department for her amazing help.

Funding was provided by SARE, No. LNC 17-396. Additional thanks to the UNL Department of Entomology for their funding and support.

Table of Contents

List of Figures

List of Tables

Chapter One: Introduction

Literature Review

Honey Bees and Beekeepers

Approximately one in every four bites of food humans eat are dependent on insect pollinators (Shepherd et al., 2003). One of the most identifiable pollinators, *Apis mellifera,* also known as the Western Honey bee, are generalist pollinators, meaning they pollinate a variety of plants (vanEngelsdorp & Meixner, 2010). Honey bee pollination is estimated to contribute anywhere from $1.6-$18.9 billion to U.S. agriculture (National Resource Council, 2007). While honey bees are important to the food system, beekeepers often experience high colony loss rates. From 2010 - 2019, over a single winter, beekeepers lost an average of 40% of their honey bee colonies in the United States (Bruckner et al., 2020). The loss of honey bees has had significant impacts on the pollinating economy, as honey bee decline means fewer crops are pollinated, leading to less production or lower quality crops, and subsequently a smaller profit for farmers (Gallai et al., 2009). The number of honey bee colonies in the United States has remained relatively stable from 1995 to 2016 due to the ability to split colonies to replace dead colonies, however, replacing colonies does require a higher input of labor and money from the beekeepers (Ferrier et al., 2018). While the number of honey bee colonies in the United States is relatively stable, we need to prepare for the future where there will be a higher demand for food pollination with the same or fewer number of colonies.

One such industry that heavily relies on honey bees is almonds. Commercial beekeepers can earn money by moving their honey bees to California to aid in almond pollination. The California almond industry employs approximately 1.5 million honey bee colonies (United States Department of Agriculture, 2020a). Due to the almond industry's reliance on honey bees for pollination, there has been lots of research on its impacts on honey bee health and the increasing demand for pollination services. Beekeepers typically lose between 20-40% of their honey bee colonies every winter, but if honey bee populations decrease by an additional 20%, it is predicted that almond harvest would decrease slightly by 0.11% (Lee, Sumner & Champetier, 2019). However, the cost for beekeepers to maintain their hives would increase 21.97% and the pollination fee charged to almond growers increases 2.9% (Lee, Sumner & Champetier, 2019). This significant increase in the cost to beekeepers would make it difficult for beekeepers to continue to maintain their hives and the increased cost to almond growers would result in an increase in almond prices beyond what the average consumer may be willing to pay.

Eighty-seven percent of the world's leading global food crops require some form of animal pollination (Klein et al., 2007). As the global population continues to rise (United Nations, 2019), we can expect an increase in food crop demand. However, honey bee populations have only increased 45% worldwide (1961-2007), while at the same time the agricultural crops needing pollination have increased 300% (Aizen & Harder, 2009).

There are a variety of factors impacting honey bee health and decline: pests, pathogens, pesticides, poor management by beekeepers and a lack of available food

resources. In addition to how these factors individually impact bees, all of these factors interact and can have compounding effects on honey bees. Agrochemicals can directly reduce food availability to honey bees, by either contaminating floral resources with insecticides (Decourtye, Mader, & Desneux, 2010) or by reducing the quantity of available floral resources (Donkersley et al., 2014; Donkersley et al., 2017). A singular issue may also be exacerbated by the presence of other factors. A colony with a large population can more easily defend against pests (Spiewok et al., 2007), but if the population of a colony is decreasing due to high levels of pesticides (Frazier et al., 2015), the colony may not be able to fight off the pest. All of these factors interact with each other. While honey bee colonies might be able to withstand one factor, such as pesticides, poor management, etc., they often are unable withstand the impacts of multiple factors.

One of the greatest threats to honey bees is the ectoparasite *Varroa destructor* (Honey Bee Health Coalition, 2018; Huang, 2012). *Varroa* originally parasitized only *Apis cerana* but then spread to *Apis mellifera* (Rosenkranz, Aumeier, & Ziegelmann, 2010). It was first detected in the United States in 1987 (Werner & Bushing, 1996), and has been linked to widespread losses of honey bee colonies since 2006 (Le Conte, Ellis, & Ritter, 2010). This is because they feed on the fat bodies of the honey bees (Ramsey et al., 2018), which can lead to impaired development (Bowen-Walker & Gunn, 2003), reduced immunity (Yang & Cox-Foster, 2005), and reduced longevity (Amdam et al., 2004). *Varroa* is also known for vectoring approximately 14 different viruses that can infect honey bees (Kang et al., 2016). Given the negative impacts of *Varroa*, it is important for beekeepers to

manage and keep mite levels low. However, *Varroa* is difficult to manage due to its life cycle. They have two life cycle phases: a phoretic phase where it lives amongst the honey bees in the colony, and a reproductive phase, where it reproduces under the wax brood capping (Huang, 2012). Spending part of its life cycle underneath the wax brood capping makes *Varroa* difficult to treat and manage, as it is hard to permeate the wax cappings to kill *Varroa* without also killing off the honey bee larva or pupa. Beekeepers are encouraged to use a mixture of chemical, cultural, and mechanical *Varroa* management methods (Honey Bee Health Coalition, 2018). But, using multiple management strategies can be time consuming and costly for beekeepers, increasing the difficulty of management for beekeepers. It also takes a significant investment by beekeepers in learning how to identify signs of *Varroa* infestation and proper management strategies.

Honey bees are largely dependent on their beekeeper to provide them with adequate food, shelter, and water sources (Winston, 1987). Beekeeper management practices influence the health of a hive, and not providing the proper care to the hive can hurt the hive (Sperandio et al., 2019). Beekeepers can help supplement the food and water found near the hive through feeding sugar and pollen, providing artificial water sources, or ensuring that apiary locations provide these resources naturally (often seasonally) to the bees. To best manage colony health, beekeepers must take into account many factors including, seasonally available food and water resources in a location, signs of disease and stress, population numbers, ratio of workers and drone bees, and queen health. However, methods for management can vary greatly across different geographical locations, and the amount of available information can

be overwhelming for beekeepers to sift through. One way to mitigate the impacts of these factors is to provide beekeepers with educational experiences and resources on how to better care for their hives (Findlay et al., 2015; Jacques et al., 2017). As a result, beekeepers often stress the importance of receiving a formal beekeeping education (i.e. attending beekeeping courses) to ensure that newer beekeepers learn proper care tactics (Maderson & Wynne-Jones, 2016). Thus, it is important to understand the experiences of beekeepers, so extensionists and educators can better understand how to educate and collaborate with beekeepers to maintain healthier colonies.

Due to the required upkeep, honey bees are often considered an agricultural commodity. There are three different types of beekeepers: hobbyists (maintains less than 100 colonies), sideliners (maintains 101-500 colonies), and commercial beekeepers (over 500 colonies) (Breckner et al., 2020). There are also a variety of services or economic ventures that beekeepers can be involved in; pollination services (providing pollination to farmers), value added products (making products such as candles, lip balms, lotions from beeswax), selling beeswax, selling honey, selling queen bees, and selling bee hives, packages, or nucleus colonies. Beekeepers may debate the classification of honey bees as livestock, as some beekeepers beekeep as a hobby while others beekeep as a profession. Many professional organizations in the United States, such as the American Veterinary Association and the United States Department of Agriculture consider honey bees livestock due to the pollination services and honey provided from bee colonies in commercial

operations (American Veterinary Medical Association, 2017; United States Department of Agriculture, 2020a).

In 2019, beekeepers earned approximately $310 million from pollination income (United States Department of Agriculture, 2020b). The USDA National Agricultural Statistics Service has recorded honey bee colonies in the USDA Census of Agriculture since 1969. There were an estimated 2.81 million managed colonies in the United States in 2019 (United States Department of Agriculture, 2020b). The Bee Informed Partnership (BIP), which collects self-reported beekeeping data, recorded a 43.7% colony loss from April 1, 2019 to April 1, 2020 (Bruckner et al., 2020). Across their 14-year survey, BIP has recorded an average winter colony loss of 28.6%, with a low of 22.2% overwintering colony loss in 2019 (Bruckner et al., 2020). BIP recorded a 10.2% overwinter colony loss for 2019/2020 in Nebraska, however this number only included ten beekeepers across the state (Bruckner et al., 2020). While we have data on honey bee colonies in the United States, we lack published information on the demographics and experiences of the beekeeping community.

While there is a lack of demographic information available on beekeepers, a majority of beekeepers are thought to be male (Ogaba, 2001), and a growing number of new beekeepers are women (Aubrey, 2010). However, women beekeepers may face issues with commonplace sexism from peers and colleagues or being unable to do the work since women's bodies are not often considered in designing agricultural equipment. For example, women beekeepers struggle finding suits that fit properly as these suits are often designed for men. In the 1800's

women were not allowed to sit-in and be a part of beekeeper association meetings in the United States even though women would take part in beekeeping enterprises (Horn, 2010; Horn, 2012). As in other professions, women are questioned as to how they plan to balance beekeeping with motherhood (Horn, 2012) and if they can handle the heavy lifting required in beekeeping (A.I. Root Company, 1906; Rogers, 2016). While there is limited literature on women beekeepers' experiences, we can look more broadly at studies of women in agriculture to gain insights.

Women in Agriculture

While agriculture is perceived as a space for men, about half of the world's farmers are women (World Bank, 2017). In the United States, half of the farmland is owned by women (Eells & Soulis, 2013), and 32% of Nebraskan farmers are women (United States Department of Agriculture, 2017). Women often report feeling isolated and disrespected by their men peers (Sachs et al., 2016; Trauger, 2004), and women farmers are often not taken as seriously as men farmers (Brasier et al., 2009). This can be attributed to: (1) financial barriers for entry into industrial agriculture, in that it is expensive to buy land and farm equipment which is typically passed from a father to a son and not to a daughter, (2) increased use of capital-intensive technologies that are often only designed with men-type bodies in mind, and (3) enduring sexism in agricultural institutions (Sachs et al., 2016). Such barriers can prevent women from wanting to join the field of agriculture, as well as making it physically and financially difficult to continue their participation.

While a man's primary path into farming is often through inheritance, a women's primary path is usually through marriage (Sachs et al., 2016). Such a path then leads women to take on the role of "farm wife," where she handles hiring employees and financial records, instead of becoming the actual farmer. While there is financial security and a level of respect that comes with the title of farm wife (Sachs et al., 2016), many women who operate or co-operate a farm want to be recognized as a farmer and not as a farm wife (Trauger, 2004). Using the term farm wife isolates women from their role as a farmer by enforcing the idea that women cannot or should not be working the land. Regardless of their actual role, most women are considered farm wives if they have a husband who helps on the farm (Trauger, 2004). If women are consistently reduced to a "farm wife" instead of being recognized for their actions, then they may not want to enter or continue in agricultural professions.

There are multiple factors in addition to terminology that prevents women from wanting to enter agriculture. Men take women farmers more seriously if the women use machinery, but machinery is often not made with a woman's body in mind, making it difficult for women to use (Sachs et al., 2016). Frequently there is no familial support in managing farms, due to a lack of good childcare in rural communities (Brasier et al., 2009), or spousal or partner support (Jarosz, 2011). Another common complaint of women is men's unwillingness to teach them. If something were to break down on a farm, rather than teaching or showing women how to fix it, men often just fix it themselves. This approach denies women valuable learning moments and reinforces the idea that agriculture should be done only by

men (Trauger et al., 2008). Women in agriculture also receive less education, as men learn farming skills from their fathers or mentors, and women are often left out of these informal learning experiences (Sachs et al., 2016). Additionally, agricultural courses for women usually focus more on bookkeeping or hiring farm help (Shortall, 1996). Women require consideration in the field of agricultural because more women are becoming farmers (Meredith, 2008). While women face many challenges, there are networks that aim to support women, such as the Women, Food and Agriculture Network (WFAN) program for women landowners, which helps them network and learn from other women in agriculture.

While larger farming and ranching enterprises may not be the most welcoming of women, sustainable spaces, which are farms that focus on preserving the environment (National Institute of Food and Agriculture, 2020), tend to be more accepting. A survey of women found that most feel more comfortable working in the sustainable agriculture space because (1) there are already more women in sustainable spaces compared to industrial spaces, (2) sustainable agriculture is more in line with their ideals, (3) since these operations are often smaller in scale, it is physically easier for women to operate, and (4) it is financially easier for women to operate - or as one respondent said “they can do the work” required for sustainable spaces (Trauger, 2004). Additionally, women feel more respected and empowered in sustainable spaces (Trauger, 2004). Previous literature shows that women want to be involved in agriculture, but need to be provided the education and opportunity to join. Sustainable agriculture has successfully created a niche for women in agriculture, and we need to examine why women are more involved in

sustainable farming practices and how we can implement those practices in other areas of agriculture, such as beekeeping.

Gender and Agricultural Education. Agricultural education comes from many different sources - extensionists, governmental agencies, and most often, other farmers (Garback & Morgan, 2017). Differences in learning styles between genders contribute to women feeling ignored by industrial agriculture spaces. Women usually prefer experiential or discussion-based learning, and men prefer a lecture-based format (Bancheva & Ivanova, 2015; Brasier et al., 2009). Agricultural conventions or workshops tend to utilize the lecture-based format, which may isolate women from their learning, as women farmers report wanting more experiential learning opportunities in place of lectures (Brasier et al., 2009). Women report feeling more empowered and confident in their education when learning from others in a group instead of a lecture (Macoloo et al., 2013; Mburu et al., 2015; Shortall, 1996).

Furthermore, women attending agricultural events report attending not only for the education, but also for the social interaction with other farmers, whereas men report attending solely for the education (Kiernan et al., 2012). Therefore, women may prefer gender segregated events, as they feel more comfortable interacting with others and asking questions if there are other women in the room (Sachs et al., 2016). Lecturers and extension educators report that men tend to ask questions during the Q&A portion of presentations, while women usually wait the talk was over to ask question in private in order to avoid looking “stupid” in front of their male colleagues (Sachs et al., 2016). Another issue is that many educational

events cover topics that do not address women's interests, or only invite the husband. This results in women feeling left out of these opportunities (Shortall, 1996).

A woman's education is not only important in ensuring that women can appropriately manage their farms, but also how others perceive her as a farmer. Men perceive women farmers to be more knowledgeable when having seen them at educational events or knowing that they have attended such events (Shortall, 1996). This point is contradictory, in that men view educated women as more knowledgeable, but women do not feel comfortable attending educational events. Therefore, we need to rectify this issue and ensure that women have access to encouraging educational environments so they can feel empowered and knowledgeable.

Women Beekeepers. There is very limited literature on women beekeepers. In her book, Horn (2012) discusses women in beekeeping across the globe and notes the lack of literature describing women beekeepers. The existing literature describes challenges that women beekeeper face as similar to those mentioned in other fields of agriculture. For example, Colopy (2015) interviewed women beekeepers holding elected or appointed positions in beekeeping associations. Colopy (2015) found some women that were welcomed with "open arms" in joining these associations, while others report being unable to hold positions in their beekeeping association due to their gender. Even today some beekeeping associations in the United States will not let women hold certain board positions (Colopy, 2015). This is nothing new as in the 1800's women were not welcomed at

beekeeper association meetings (Horn, 2012). Another issue that women beekeepers face is that they are often questioned by men as to how they plan to balance beekeeping with motherhood (Horn, 2012). Women are also questioned as to whether they can handle the heavy lifting required in beekeeping (A.I. Root Company, 1906; Rogers, 2016), even though lifting a heavy honey super can be challenging for both genders (Rogers, 2016). Not surprisingly, many beekeepers report feeling that they need to prove themselves to their employers and co-workers (Colopy, 2015; Horn, 2012; Rogers, 2016).

Even within our own experiences at the University of Nebraska-Lincoln, most of our bee classes are taught using ten frame equipment, which women may not use because it is too heavy to lift without the help of someone else. We teach using this equipment as it is the most commonly used equipment in the U.S. As a result, some women may be discouraged from beekeeping thinking that smaller or lighter equipment is not available. Furthermore, women who do keep bees in alternative hives using lighter equipment find less guidance on how to manage their hives as alternative hives are uncommon and there are fewer experts available to guide management of these hives. Beyond this, members of our own research team and other women beekeepers in our courses have noticed issues finding jackets and beekeeping suits that appropriately fit - even a small is sometimes too big.

While women beekeepers experience different challenges and inequities than men, historically, women have been encouraged to keep bees. The “father of beekeeping” Lorenzo Langstroth emphasized the importance of women having access to beekeeping and giving women a reason to be outside (Horn, 2012).

During- and post-Civil war in the United States many women took over their husbands or fathers beekeeping business when the men left for war, which created a small space for women in beekeeping (Horn, 2012). Old records of beekeeping journals even show that women would write, submit, and publish articles on beekeeping, and women were encouraged to keep bees as a way to supplement household income (A.I. Root Company, 1906; Horn, 2012). Some have even noted that women may be better beekeepers or more respected beekeepers because they are "more gentle and delicate" in handling bees (Burlew, 2018; Horn, 2012). While we have some information regarding women beekeeper's experiences, the evidence provides an incomplete (and even contradicting) picture of women beekeepers needs. Thus, there is a need to further explore women's experiences as beekeepers. There is also a need to explore educational programming effects on women's understanding of beekeeping and implementation of management practices. With this information we can inform educators about the needs of women beekeepers, suggest approaches for learning experiences, and determine expected outcomes from educational programming tailored for women beekeepers.

Research Problem

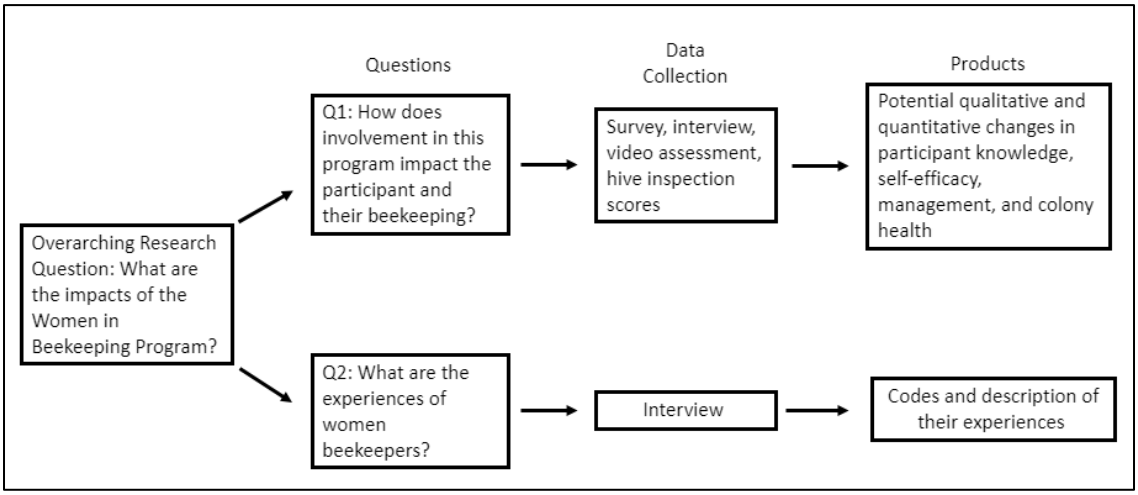
Fueled by an interest in environmentalism, and wanting to return to nature, more women are entering the field of beekeeping (Aubrey, 2010), and agriculture in general (Sachs et al., 2016; Trauger, 2004). Management of bees, and as a result their survival, is at least partially dependent on the care provided by the beekeeper (Sperandio et al., 2019). Thus, it is important to understand the experiences of

beekeepers. Women beekeepers are of importance because they might face different challenges than men beekeepers, and as educators we need to account for these potential differences in their educational programming. We need to understand what challenges and struggles women beekeepers face and if these are linked to their gender identity, physical capabilities, or lack of knowledge in beekeeping practices. This information is critical to understanding any deficiencies in knowledge and in addressing any specific training needs for new and experienced women beekeepers.

The purpose of the overall study is to support hive health, agricultural education, and pollinator populations. Within this research project, there are two studies (Figure 1.1). The first study (1) examines the impacts of the Center for Rural Affairs Women in Beekeeping program on participants and (2) the second study describes the experiences of these women beekeepers. The Center for Rural Affairs (CFRA) hosts a "Honey Bees on the Farm: Connecting Women Beekeepers and Women Farmers for Environmental and Economic Benefit" program for new and experienced beekeepers and landowners. Their goal is to create a collaborative, informal learning environment for women. The topics covered in this program include honey bee management practices, contracts for beekeeping, habitat management, and pollinator conservation. Most instruction was delivered through a series of learning circles (See ***Learning Circles*** in Chapter 2). This study examines the intended and unintended impacts of this program and the experiences of participants.

Figure 1.1

Diagram of the research questions, data collections methods, and products of this research



Research Questions

In this quasi-experiment, I followed nine beekeepers who participated in the Women in Beekeeping program. I tracked their hive health and observed their behavior while beekeeping over an entire beekeeping season (March to November). Additionally, I assessed their knowledge, management skills, and self-efficacy (an individual's belief that they can or cannot complete a task) before the start of the season and after the season ended. I also asked non-program participants (women beekeepers who did not partake in the Women in Beekeeping program) questions regarding their management, self-efficacy, and knowledge to compare to program participants. Additionally, participants were asked questions regarding their experiences as a woman beekeeper.

This project aims to answer the research question: what are the impacts of the Women in Beekeeping Program? This question is divided into two sub-questions: (1) How does involvement in the Women in Beekeeping program impact participants? (2) What are the experiences of women beekeepers (Figure 1.1)?

Question 1: How does involvement in the Women in Beekeeping program impact participants?

In this question I explored four sub-questions (SQ); (SQ1) how does involvement impact knowledge; (SQ2) how does involvement impact self-efficacy; (SQ3) how does involvement impact bee management; and (SQ4) how does involvement impact colony health? A convergent mixed methods research design was used, which is a design where quantitative and qualitative data are collected in parallel, analyzed separately, and then merged (Creswell & Plano Clark, 2018). In this study, survey data was collected, and quantitatively analyzed to determine how knowledge levels, management strategies, and self-efficacy levels change over time as a result of involvement in this program. Hive health scores were also collected and analyzed quantitatively. Interview data and videos of hive inspections explored how and why beekeepers use certain management strategies, as well as beekeeper knowledge, and indicators of self-efficacy. I collected both quantitative and qualitative data to compare, corroborate, and triangulate the different types of data as a way to bring greater insight to the research question than I could obtain by using either quantitative or qualitative data. See Chapter 2 for more details on this research question and design.

Question 2: What are the experiences of women beekeepers?

The second question, what are the experiences of women beekeepers, is examined with semi-structured interview questions. To answer this question, I ask two sub questions; (SQ1) are there any specific experiences unique to being a woman beekeeper?; and (SQ2) what is important to women beekeepers? For this question, I took a transcendental phenomenological approach, which is a design type in which the researcher's goal is to describe the lived experiences of participants (Moustakas, 1994). This includes their experiences with their own hives, other beekeepers, landowners, and other organizations prior to and during participation in the program. Semi-structured interviews explored the lived experiences of being a woman beekeeper in the Midwest United States. See Chapter 3 for more details on these research questions and design type.

Philosophical Foundations

"Hard sciences" such as Entomology, typically utilize a positivist or post-positivist approach to science. These approaches assume that there is an objective reality (Neumann, 2011), and that through science we may or may not be able to understand this objective reality. Given that this thesis does not use a strict quantitative approach, I utilized a constructivist epistemology. Constructivism, sometimes called interpretivism, argues that individuals construct their own reality, therefore there are multiple realities (Plano Clark & Ivankova, 2016). People's realities are shaped by their preconceived notions and social constructs (Neumann, 2011). When using a constructivist approach, researchers ask themselves what

people believe and what they hold relevant to themselves (Neumann, 2011). Each individual constructs their own reality while beekeeping, one person may perceive their bees as angry whereas another may perceive them as calm. Therefore, I must account for the fact that each individual is going to possess their own constructed reality regarding their bees.

Phenomenology as a qualitative method focuses on describing the lived experiences of the participant (Creswell & Poth, 2018; Litchman, 2013). Under this definition of phenomenology, I am essentially assuming a constructivist approach, as my goal is to describe what the participants assume to be their reality. Given that this research focuses on better understanding the realities of being a women beekeeper, the realities of the impact of the Women in Beekeeping program, and the realities the participants believe to be true, a constructivist paradigm is employed.

Audiences Who Will Benefit

There are a number of audiences that can benefit from this research. I hope that as a result of this research, educators and scientists gain insight as to how we can better design educational programs for women in agriculture. I also want to lift up the voices of women in beekeeping as a way to validate their interest's and call for improved education programs in the future. Additionally, the results from this study may be of interest to educators regarding the aspects of this program that were especially beneficial to the women's education. As educators, we want to ensure that these women are properly equipped in terms of an education and access to resources to protect their investment in their bees in terms of time, money, and

labor. Additionally, program participants benefited from their involvement. Hive inspections were provided to participants at no cost, and during these inspections they asked me questions, as well as networked with other beekeepers and landowners through the learning circles.

Educators, extensionists, and administrators can benefit from this research. They can use the information provided by participants to better structure their programs and recruit participants into their programs. For example, they can improve programs by including different topics or hands-on activities at the suggestion of the participants. There is a growing body of research regarding agricultural education and education of the genders, and this research contributes to both pools of literature.

I expected to find that women benefit from this program by gaining a network of other women beekeepers. However, if it was found that gender did not actively play a role in the experiences of women beekeepers and instead find that other factors (e.g. age, physical ability, previous experience) do, then we can adjust educational programs to account for these attributes. Ultimately this information will lead to better and more customized educational experiences for women beekeepers.

Key Terms

Beekeeping Terms

Here is a list of beekeeping terms that may be useful in reading this manuscript.

- Box: refers to the physical box that is used to hold honey bee frames

- Colony: The population of bees in the hive.
- Hive: The physical structure where honey bees live, such as the boxes and frames that the bees live on. The words “colony” and “hive” are often used interchangeably even though they have two different definitions.
- Hive tool: A tool used primarily to help a beekeeper pull frames out of the hive.
- Jacket: For the purposes of this thesis, the word “jacket” refers specifically to a bee jacket. This is typically a piece of white clothing that was made to protect a beekeeper from being stung.
- Smoker: A tool that allows beekeepers to make smoke to calm down honey bees while inspecting their colony.
- Veil: A mesh head covering that is worn to protect the beekeepers face from being stung.
- Working bees: A phrase that is commonly used to refer to inspecting a hive.

CFRA Women in Beekeeping program

The Center for Rural Affairs (CFRA) in Nebraska hosts the “Honey Bees on the Farm: Connecting Women Beekeepers and Women Farmers for Environmental and Economic Benefit” program that networks women beekeepers with women landowners. This program is referred to as the “Women in Beekeeping program” throughout this thesis. Through this program, the CFRA hosts monthly learning circles, or discussion groups, for participants. Learning circles are hosted approximately once a month from January to September and last approximately two

hours. A majority of the participants are from the state of Nebraska, however some participants are from the surrounding states, such as Kansas or Iowa. While the program is advertised as a space for women, men were welcome to join the learning circles, especially if they are joint partners in their beekeeping or landowning venture.

Hive Inspection

A hive inspection occurs when someone examines a colony of bees. The specifics may vary, but usually it involves the beekeeper visiting their hive, checking for signs of death, disease, animal attack, adequate food resources, and ensuring that the hive is overall healthy. Inspections can last anywhere from a few minutes to a few hours depending on what the beekeeper is trying to find. The hive inspection note sheet used for this project is located in **Appendix A.**

Learning Circle

A learning circle defines a group of people, in this case women, who meet regularly over a period of time to discuss and learn about a topic (Keane, 2016). Learning circles typically occur over 7-9 sessions, each session lasting from thirty minutes to two hours (Keane, 2016). As the name suggests, when groups meet in person they sit in a circle. The CFRA does not follow a typical learning circle style of leading with a prompt and then allowing everyone else to speak. Rather, presenters are brought in to talk to the group about the topic. After the presentation is over, the group is open to discuss the topic amongst themselves or with the presenter. For this

program, learning circles were held almost monthly from January to September. For more information on the CFRA learning circles, see Chapter 2.

Program Participants and Non-Program Participants

This research has two groups of participants: program participants (PP) and non-program participants (NPP). Program participants are the women beekeepers who partook in the Women in Beekeeping program and volunteered for this research project. These women completed two surveys, two semi-structured interviews, a potential third follow-up interview, and video-recorded hive inspections for this research. All of these women currently live in the state of Nebraska. The second group, non-program participants, took part in either one semi-structured interview, or one survey, and did not participate in the Women in Beekeeping program. We compare the responses of the NPPs to the PPs to further examine the impacts of the Women in Beekeeping program.

Sustainable Agriculture

Sustainable agriculture is a system of agriculture based on reducing immediate farm inputs to:

- Reduce long-term impacts on the land and environment
- Maintain or increase local biodiversity
- Utilize renewable forms of energy instead of fossil fuels (Horrigan, Lawrence, & Walker, 2002).

Sustainable agriculture is often utilized on smaller farms since the practices require a higher input of labor and time.

Woman Beekeeper

Gender identity is a person's internal sense of their own gender (GLAAD, 2016). People choose, either consciously or subconsciously, to identify with or without a certain gender (World Health Organization, 2011). These gender identities tend to come with a set of pronouns that are used to refer to the individual. For example, an individual can identify as woman and use she/her pronouns, or an individual can identify as agender, meaning they identify with no gender, and use they/them, or other, pronouns. Gender is also fluid, therefore while most people have selected a gender by age of three, some people do not identify with a sole gender (Kalbfleisch & Cody, 1995). Participants are any person that identifies or is okay with being associated with the term "woman." This includes not only individuals who use she/her pronouns, but those who use other pronouns, such as but not limited to they/them or ze/zir pronouns. Non-binary or genderfluid individuals may include themselves within this definition if they are comfortable being associated with the word "woman."

For the purposes of this study, "beekeeper" is any person that owns and manages honey bees. This does not include individuals who may own but choose not to manage their honey bees. Participants must actively own hives. This means that someone who used to keep bees but no longer keeps bees is not eligible for this research. This is due to the fact that hive inspections are part of this research.

Therefore, for the purposes of this study, and only this study, a “woman beekeeper” is defined as any person that identifies with the term “woman” and also keeps bees.

References

A.I. Root Company. (1906). *Bee-keeping for women.*

Aizen, M.A., & Harder, L.D. (2009). The global stock of domesticated honey bees is growing slower than agricultural demand for pollination. *Current Biology, 19(*11), P915-918. https://doi.org/10.1016/j.cub.2009.03.071

Amdam, G.V., Hartfelder, K., Norberg, K., Hagen, A., & Omholt, S.W. (2004). Altered physiology in worker honey bees (Hymenoptera: Apidae) infested with the mite *Varroa destructor* (Acari: Varroidae): A factor in colony loss during overwintering? *Journal of Economic Entomology, 3(*1), 741-747. https://doi.org/10.1093/jee/97.3.741.

American Veterinary Medical Association. (2017). The veterinarian's role in honey bee health: Honey bees: A guide for veterinarians.

Aubrey, A. (2010). Healing honey and the new Queenbee(keepers). *National Public Radio.* https://www.npr.org/2010/07/19/128574280/healing-honey-and-the-new-queen-bee-keepers.

Bancheva, E., and Ivanova, M. (2015). Informal learning in the workplace. In *Private World(s): Gender and Informal Learning of Adults* (pp. 157-182). Sense Publishers.

Brasier, K., Barbercheck, M., Kiernan, N.E., Sachs, C., Schwartzberg, A., & Trauger, A. (2009). Extension educators' perceptions of the educational needs of women farmers in Pennsylvania. *Journal of Extension, 47(3),* 3FEA9.

Bruckner, S., Steinhauer, N., Engelsma, J., Fauvel, A.M., Kulhanek, K., Malcolm, E., Meredith, A., Milbrath, M., Niño, E.L., Rangel, J., Rennich, K., Reynolds, D., Sagili, R., Tsuruda, J., vanEngelsdorp, D., Aurell, S.D., Wilson, M., & Williams, G. (2020). 2019-2020 Honey bee colony losses in the United States: Preliminary Results. https://beeinformed.org /wpcontent/uploads/2020/06/ BIP_2019_2020_Losses_Abstract.pdf. (Accessed June 2020).

Bowen-Walker, P.L., & Gunn, A. (2003). The effect of the ectoparasitic mite, *Varroa destructor* on adult worker honeybee (*Apis mellifera*) emergence weights, water, protein, carbohydrate, and lipid levels. *Entomologia Experimentalis et Appplicata, 101*, 207-217. https://doi.org/10.1046/j.1570-7458.2001.00905.x.

Burlew, R. (2018). Are women better beekeepers. *American Bee Journal*, *159(*7), 801-804.

Colopy, M. 2015. Women in beekeeping. *Bee Culture.* https://www.beeculture.com/women-in-beekeeping/

Creswell, J.W., & Plano Clark, V.L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing among five approaches.* SAGE Publications.

Decourtye, A., Mader, E., & Desneux, N. (2010). Landscape enhancement of floral resources for honey bees in agro-ecosystems. *Apidologie, 41*, 264-277. https://doi.org/10.105 1/apido/2010024.

Donkersley, P., Rhodes, G., Pickup, R.W., Jones, K.C., & Wilson, K. (2014). Honeybee

nutrition is linked to landscape composition. *Ecology and Evolution, 4(*21), 4195-4206. https://doi.org/10.1002/ece3.1293.

Donkersley, P., Rhodes, G., Pickup, R.W., Jones, K.C., Power, E.F., Wright, G.A., & Wilson, K. (2017). Nutritional composition of honey bee food stores vary with floral composition. *Oecologia, 185(*4), 749-761. https://doi.org/10.1007/s00442-017-3968-3.

Eells, J.C., & Soulis, J. (2013). The overlooked landowner: a review of research on women farmland in the U.S. *Women Food and Agriculture Network.* https://static1.squarespace.com/static/5ae9eb0a697a9837968fb75c/t/5c76e5ee71c10ba12c65f51f/1551295989639/WCLWhitePaper2-15-2013.pdf.

Ferrier, P.M., Rucker, R.R., Thurman, W.N., & Burgett, M. (2018). Economic effects and responses to changes in honey bee health. *USDA Economic Research Report,* 246.

Findlay, J.R., Eborn, B., & Jones, W. (2015). Effects of colony creation method and beekeeper education on honeybee (*Apis mellifera*) mortality. *Journal of Extension, 53(*1), 1RIB6.

Frazier, M.T., Mullin, C.A., Frazier, J.L., Ashcraft, S.A., Leslie, T.W., Mussen, E.D., & Drummond, F.A. (2015). Assessing honey bee (Hymenoptera: Apida) foraging populations and the potential impact of pesticides on eight U.S. crops. *Journal of Economic Entomology, 108(*5), 2141-2152. https://doi.org/10.1093/jee/tov195.

Gallai, N., Salles, J.M., Settele, J., & Vassaiere, B. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics, 68(*3), 810-821. https://doi.org/10.1016/j.ecolecon.2008.06.014.

Garback, K., & Morgan, G.P. (2017). Grower networks support adoption of innovations in pollination management: the roles of social learning, technical learning, and personal experience. *Journal of Environmental Management, 204 (*1), 39-49.

GLAAD. (2016). GLAAD media reference guide. https://www.glaad.org/sites/default/files/GLAAD-Media-Reference-Guide-Tenth-Edition.pdf.

Honey Bee Health Coalition. (2018). *Tools for varroa management: A guide to effective varroa sampling & control* (7th ed.). The Keystone Policy Center.

Horn, T. (2010). Women & Beekeeping in Longstroght's Time. *Bee Culture, 138(*6), 16-18.

Horn, T. (2012). *Beeconomy: What Women and Bees can Teach Us about Local Trade and the Global Market.* University Press of Kentucky.

Horrigan, L., Lawrence, R.S., & Walker, P. (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives, 110(*5), 445-457. https://doi.org/0.1289/ehp.02110445.

Huang, Z. (2012). *Varroa* mite reproductive biology. *American Bee Journal, 152(*10), 981-985.

Jarosz, L. (2011). Nourishing women: toward a feminist political ecology of community supported agriculture in the United States. *Gender, place and culture, 18(*3), 307-326. https://doi.org/10.1080/0966369X.2011.565871.

Jacques, A., Laurent, M., EPILOBEE Consortium, Ribière-Chabert, M., Saussac, M., Bougeard S., Budge, G.E., Hendrikz, P., & Chauzat, M. (2017). A pan-European epidemiological study reveals honey bee colony survival depends on beekeeper education and disease control. *PLoS ONE, 12(*3), e0172591. https://doi.org/10.1371/journal. pone.0172591.

Kalbfleisch, P.J., & Cody, M.J. (1995). *Gender, power, and communication in human relationships.* Routledge.

Kang, Y., Blanco, K., Davis, T., Wang, Y., & DeGrandi-Hoffman, G. (2016). Disease dynamics of honeybees with *Varroa destructor* as parasite and virus vector. *Mathematical Biosciences, 275*, 71-92. https://doi.org/10.1016/ j.mbs.2016.02.012.

Keane, B. 2016. The learning circle in culture change: why use it? *Pioneer Network.* https://www.pioneernetwork.net/wp-content/uploads/2016/10/The-Learning-Circle-in-Culture-Change.pdf.

Kiernan, N.E., Barbercheck, M., Brasier, K.J., Sachs, C., & Terman, A.R. (2012). Women farmers: Pulling up their own educational boot straps with extension. *Journal of Extension, 50(*5), 5RIB5.

Klein, A., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B, 274,* 303-313. https://doi.org/10.1098/ rspb.2006.3721.

Le Conte, Y., Ellis, M., & Ritter, W. (2010). *Varroa* mite and honey bee health: Can *varroa* explain part of the colony loss? *Apidologie, 41(*3), 353-363. https://doi.org/10.1051/apido/2010017.

Lee, H., Sumner, D.A., & Champetier, A. (2019). Pollination markets and the coupled futures of almonds and honey bees: Simulating impacts of shifts in demands and costs. *American Journal of Agricultural Economics, 101(*1), 230-249. https://doi.org/10.1093/ajae/aay063.

Litchman, M. (2013). *Qualitative research in education* (3rd ed.). SAGE Publications.

Macoloo, C., Recha, R., Radeny, M., & Kinyangi, J. (2013). Empowering a local community to address climate risks and food insecurity in Lower Nyando, Kenya. *Case Study prepared for Research Program on Climate Change, Agriculture and Food Security.*

Maderson, S., & Wynne-Jones, S. (2016). Beekeepers' knowledges and participation in pollinator conservation. *Journal of Rural Studies, 45*, 88-98. https://doi.org/10.1016/j.jrurstud.2016.02.015.

Mburu P., Affognon, H., Irungu, P., Mburu, J., & Suresh, R. (2015). Beekeeping for women empowerment: Case of commercial insect programme in Kitui County, Kenya. *Conference Paper: International Association for Feminist Economics.*

Meredith, A.M. (2008). Conserving pollinators: an interdisciplinary approach to evaluating the ecological, economic and cultural value of native bees in mid-Atlantic sustainable agriculture. [Doctoral Dissertation, University of Maryland]. ProQuest Dissertations and Theses.

Moustakas, C. (1994). *Phenomenological Research Methods.* SAGE Publications.

National Institute of Food and Agriculture. (2020). *Sustainable Agriculture.* United

States Department of Agriculture. https://nifa.usda.gov/topic/sustainable-agriculture.

National Resource Council. (2007). *Status of Pollinators in North America.* National Academies Press.

Neumann, W.L. (2011). *Social research methods: Qualitative and quantitative approaches* (7th ed.). Pearson.

Ogaba, M.R. (2001). Gender issues in beekeeping: the Uganda case. *Apidmondia International Apicultural Congress.* Durban, South Africa.

Plano Clark, V.L., & Ivankova, N.V. (2016). *Mixed methods research: A guide to the field.* SAGE Publications.

Ramsey, S.D., Ochoa, R., Bauchan, G., Gulbronson, C., Mowery, J.D., Cohen, A., Lim, D., Joklik, J., Cicero, J.M., Ellis, J.D., Hawthorne, D., & vanEngelsdorp, D. (2019). *Varroa destructor* feeds primarily on honey bee fat body tissue and not hemolymph. *PNAS, 116(*5), 1792-1801. https://doi.org/10.1073 /pnas.1818371116.

Rogers, K. (2016). The beeyard ain't no place for a woman: female beekeepers of grey and bruce. *Ontario Bee Journal.*

Rosenkranz, P., Aumeier, P., & Ziegelmann, B. (2010). Biology and control of *Varroa destructor. Journal of Invertebrate Pathology, 103,* S96-S119.

Sachs, C.E., Barbercheck, M.E., Brasier, K.J., Kiernan, N.E., & Terman, A.R. (2016). *The Rise of Women Farmers and Sustainable Agriculture.* University of Iowa Press.

Shepherd, M., Buchmann, S., Vaughan, M., & Black, S. (2003). *Pollinator Conservation Handbook*. The Xerces Society.

Shortall, S. (1996). Training to be farmers or wives? Agricultural training for women in Northern Ireland. *Sociologia Ruralis, 36(*3), 269-285. https://doi.org/10.1111/j.1467-9523.1996.tb00022.x.

Sperandio, G., Simonetto, A., Carnesecchi, E., Costa, C., Hatjina, F., Tosi, S., & Gilioli, G. (2019). Beekeeping and honey bee colony health: A review and conceptualization of beekeeping management practices implemented in Europe. *Science of the Total Environment, 696(*15), 133795. https://doi.org/10.1016/j.scitotenv.2019.133795.

Spiewok, S., Pettis, J.S., Duncan, M., Spooner-Hart, R., Westervelt, D., & Neumann, P. (2007). Small hive beetle, *Aethina tumida*, populations I: Infestation levels of honeybee colonies, apiaries, and regions. *Apidologie, 38*, 595-605. https://doi.org/10.1051/apido:2007042.

Trauger, A. (2004). 'Because they can do the work': women farmers in sustainable agriculture in Pennsylvania, USA. *Gender, Place and Culture, 11(*2), 289-307. https://doi.org/10.1080/0966369042000218491.

Trauger, A., Sachs, C.E, Barbercheck, M.E., Kiernan, N.E., Brasier, K.J., & Findeis, J. (2008). Agricultural education: gender identity and knowledge exchange. *Journal of Rural Studies, 24*, 432-439. https://doi.org/10.1016 /j.jrurstud.2008.03.007.

United Nations. (2019). *World Population Prospects 2019: Highlights* (ST/ESA/SER.A/423). Department of Economic and Social Affairs, Population Division. https://population.un.org/wpp/Publications/ Files/WPP2019_Highlights.pdf.

United States Department of Agriculture. (2017). Nebraska: State and County Data. *2017 Census of Agriculture.*

United States Department of Agriculture. (2020a). Honey bee colonies. *National Agricultural Statistics Service.* https://downloads.usda.library.cornell.edu/usda-esmis/files/rn301137d/nc58193 80/t148g6070/hcny0820.pdf.

United States Department of Agriculture. (2020b). Honey Report. *National Agricultural Statistics Service*. https://www.nass.usda.gov/Publications/Todays_Reports/reports/hony0320.pdf.

vanEngelsdorp, D., & Meixner, M. (2010). A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them. *Journal of Invertebrate Pathology, 103*, 80-95. https://doi.org/10.1016/j.jip.2009.06.011.

Werner, A.M., & Bushing, W.W. (1996). *Varroa* mite spread in the United States. *Bee Culture, 124(*6), 341-343.

Winston, M. L. (1987). *The Biology of the Honey Bee.* Harvard University Press.

World Bank. (2017). Women in agriculture: the agents of change for the global food system. https://www.worldbank.org/en/news/feature/2017/03/07/women-in-agriculture-the-agents-of-change-for-the-food-system.

World Health Organization. (2011). Gender mainstreaming for health managers: a practical approach. *WHO Department of Gender, Women and Health.*

Yang, X., & Cox-Foster, D.L. (2005). Impact of an ectoparasite on the immunity and pathology of an invertebrate: Evidence for host immunosuppression and viral amplification. *PNAS, 102(*21), 7470-7475. https://doi.org/10.1073/pnas.0501860102.

Chapter 2: Impacts of a Beekeeper Educational Program on Women: A Convergent Mixed Methods Study

"It helped me a lot doing the inspections, to recognize things I can look for and things that I didn't really think about. And it made me think more while I'm in there. Well, what about this, this or that or what's the cycle of the, you know, how the, what looks like in the hive? It helped me a lot." - Janet

Literature Review

This section defines knowledge, self-efficacy, hive health, and management as it pertains to this research project. I review these topics to describe why I conducted this research and provide context with which to discuss our results.

Knowledge

Knowledge is defined as the information or skills a person acquires through education or experiences. Acquiring knowledge can occur through both informal and formal educational environments. Research regarding knowledge and education is important in deciphering how humans can more effectively teach and learn. People often experience "slippage" between levels of knowledge, in that they have difficulty synthesizing multiple pieces of information (Wilensky & Resnick, 1999). For example: students often have trouble connecting pollination to the reproduction of plants (Golick et al., 2017). One needs to understand the isolated parts of a system to avoid slippage. For example, one needs to understand the process of pollination to understand its importance in the food system. Thus, it is important for the learner to have access to different types of data to help fully understand a complex system (Hmelo-Silver & Azevedo, 2006). These concerns can be addressed within both formal and informal learning environments.

It is estimated that about three-fourths of all learning is informal, and approximately two-thirds of adult learning is informal (Bacheva & Ivanova, 2015). Informal learning is learning that occurs outside of a structured classroom environment (Ainsworth & Eaton, 2010). In agriculture, such opportunities may include outreach or extension events, citizen science programs, and informal discussion sessions. During these events, information is often passed from more experienced members to less experienced members, similar to the idea of transference in citizen science (Lynch, 2016).

While informal learning is important, where the information comes from is equally important. Farmers receive most of their knowledge through informal routes, such as other farmers, and highly value informal information that is more relevant to their location and specific to their struggles (Šūmane et al., 2018). However, they may receive information that is not pertinent to them when learning from other farmers. Learning from others also raises concerns about false information being spread, and may only lead to short-term educational benefits (Lukas & Ross, 2005).

Additionally, participant knowledge tends to be very specific around localized knowledge or problems, forming knowledge gaps. For example, a study found that Ecuadorians were highly knowledgeable regarding the local environment and bear conservation, but less knowledgeable regarding general ecology (Espinosa & Jacobson, 2012). Learning is socially situative and is specific to a situation and culture group (Lave, 1991). Farmers tend to learn from other farmers, but often complain and seek to fill their own knowledge gaps regarding crop pollination

(Garback & Morgan, 2017). Therefore, while informal learning is important, it can leave many participants with knowledge gaps.

Providing good information is key to rectifying issues of false information, localized knowledge, and reducing knowledge gaps. However, there also needs to be high levels of engagement and collaboration which leads to increased participant knowledge (Druschke & Seltzer, 2012; Sponarski et al., 2016), and a trusting relationship between educators and participants. (James, 2002; Steyaert et al., 2007). Awareness of the culture in which one is learning and how that culture impacts the participant's learning is key to providing better educational experiences (Lave, 1991). Understanding the context in which someone is learning, such as from whom they receive their information, what information they lack, and what educational sources of information they trust, allows educators to design programs that address participants learning styles in addition to participant's knowledge gaps.

In addition to informal opportunities, formal education can help address some of these knowledge gaps. However, these events often miss groups of people that are not commonly associated with agriculture, such as women (Shortall, 1996; Trauger et al., 2008). This might occur because formal educational events only invite or provide courses geared more towards men (Shortall, 1996). Other events might also be restrictive to women based on their wealth, with some educational events targeted at large land owners (Trauger et al., 2008). Additionally, formal programs may not provide the information that participants need. Studies have shown that crop pollination is a top-rated management priority for farmers (Garback & Morgan, 2017), but farmer education focuses more on pest control (Meredith, 2008). This

focus on a limited range of knowledge may lead to gaps in farmer's knowledge. Similarly, in college education many programs have little focus on sustainable agriculture or experiential agricultural learning (Parr et al., 2007). Farmers often turn to informal learning opportunities to gain information on new and emerging practices (Maguire, 2000). To better meet the needs of agriculture professionals and provide learning on new and emerging issues, educational programs must adjust their teaching strategies (Maguire, 2000).

More experienced beekeepers often stress the importance of receiving a formal beekeeping education (i.e. attending beekeeping courses) instead of informal training (Maderson & Wynne-Jones, 2016). Beekeepers who have received a formal education were able to manage their colonies better, and as a result, their colonies had higher survival rates than beekeepers who did not receive a formal education (Findlay, Eborn & Jones, 2015). However, formal educational opportunities are not accessible to everyone, specifically women or other minorities, either due to financial or time barriers (Sharafizad, 2018) or due to their educational needs (Brasier, et al., 2009).

To address this problem, the Center for Rural Affairs (CFRA) in Nebraska offered learning circles to women beekeepers and landowners. These events created an informal, experiential learning environment for women. The goal of the program was to provide women beekeepers with knowledge and experiences leading to better honey bee management skills and improved hive health. This research examines how participation in the Women in Beekeeping program impacts participant's knowledge, self-efficacy, management, and colony health.

Self-Efficacy

Self-efficacy (SE) is one's perceived ability to achieve their goals (Bandura, 1986). Self-efficacy is specific to its domain of function or topic at hand (Bandura, 2006). For example, SE in solving basic math can vary greatly from one's SE related in writing. Multiple factors influence SE. Bandura (1986) outlines four main sources of influence:

1. Performance attainments: the most influential source of SE, this focuses on one's past experiences with the task at hand.
2. Vicarious experiences: observing similar people perform the task at hand persuades people to believe that they can achieve the same task.
3. Verbal persuasion: persuading oneself based on what others have said or told them.
4. Physiological state: one's emotions regarding their abilities.

Self-efficacy is subjective, as they are based on the subject's perceptions of reality, not necessarily their actual ability (Stajkovic, 1996). This perception can drastically influence one's ability to complete a task. Low levels of SE correlate with not completing tasks (Stajkovic, 1996). Writing students with higher levels of SE were more likely to work harder and write for longer periods of time (Holmes, 2016). Higher levels of SE correlate with a stronger work ethic, better productivity, and higher rates of task completion (Holmes, 2016; Schunk, 1984; Stajkovic, 1996). For example, Graduate students who participated in writing workshops had higher levels of SE over time and felt more confident in their writing abilities (Schneider-Cline, 2015). People constantly internally monitor their performance on tasks

through self-evaluation and self-efficacy can change during the performance of a task (Holmes, 2016). Self-efficacy also changes over time as a person acquires new knowledge and gains experience.

While knowledge and education are important, so is one's perceived ability to implement strategies. For example, those learning new farming technologies are more likely to utilize technology when they believe that they have the capabilities to utilize it correctly (Wuepper, Zilberman, & Sauer 2019). In this study, I am interested in the SE of beekeepers because if beekeepers have low SE, then they may be less likely to initially pursue beekeeping, continue beekeeping, or pursue future educational opportunities. Persistence in beekeeping is especially important as most beekeepers suffer setbacks that are out of their control, such as high overwintering colony loss due to weather. It is important to improve self-efficacy of beekeepers so they are resilient in continuing to beekeep despite setbacks. Extension educators also want beekeepers to continue seeking educational opportunities that make them better beekeepers and equip beekeepers to be able to deal with emerging factors that affect colony health.

Hive Health and Management

The Xerces Society estimates that one in four bites of food that humans eat requires an animal pollinator (Shepherd et al., 2003). Over 150 food crops in the United States rely on insect pollinators to set fruit or seed (U.S. Forest Service, 2020). With global agricultural production increasing 140% between 1961 and 2006, our dependency on pollinators has increased 50% (Aizen et al., 2009). Honey bees are

often noted as the “most important” pollinator due to their practicing flower constancy. Flower constancy is defined as the tendency of a pollinator to exclusively visit a specific flower species or morph (Shepherd et al., 2003). *Apis mellifera,* also known as Western Honey bees, are generalist pollinators (vanEngelsdorp & Meixner, 2010). Honey bees have high levels of floral constancy within singular foraging trips (Grüter et al., 2011). They also recruit foragers to visit certain floral resources (Seeley, 1994). Honey bees are also important pollinators due to their ability to be kept in hives and move where pollination is need. Honey bee pollination is estimated to contribute anywhere from $1.6-$18.9 billion to U.S. agriculture (National Resource Council, 2007). The decline of honey bees may have significant impacts on the pollinating economy. Honey bee decline can lead to fewer crops being pollinated, causing a drop in pollination services, and subsequently crop yields (Gallai et al., 2009; Lee, Sumner & Champetier, 2019). Grünewald (2010) estimates that a complete loss of bee pollination would reduce the monetary value of stimulant crops (ie. coffees, teas) by 39%, and the value of nuts by 31%. Honey bee decline significantly impacts pollination, an issue as the demand for pollination of crops increases.

Pollinator decline can be addressed in many ways. Organizations for the conservation of pollinators recommend increasing forage, providing higher quality habitat areas, and a reduction in the use of harmful chemicals (Shepherd et al., 2003). Many pollinators can be helped by increasing the diversity of wild forage throughout the year (Dicks, Showler, & Sutherland, 2010; Meredith 2008; Shepherd et al., 2003). Diversifying agroecosystems has also been suggested to improve

pollinator health, including growing a number of different crops in one area and planting different species of the same crop to increase plant biodiversity (Love & Spaner, 2008).

One stressor on honey bee health is the loss of forage, and a reduction in the quality of available forage (Shepherd et al., 2003). Nectar from flowers provides bees with the necessary carbohydrates, and pollen provides the necessary proteins and lipids (Herbert, 1993). Honey bees are estimated to need 25 kilograms of pollen (Keller, Fluri & Imdorf, 2005) and over 300 kilograms of nectar in temperate regions to survive the summer and winter months (Huang, 2010). Since honey bees only feed on nectar and pollen, the nectar and pollen they consume needs to meet all of their nutritional requirements (Winston, 1993). Consuming a diversity of pollen helps honey bees combat pests and pathogens (Alaux et al., 2010; Grandi-Hoffman et al., 2016), as well as increase their ability to detoxify pesticides (Mao, Schuler, & Berenbaum, 2013). Honey bee health will decline when they are missing certain nutritional requirements (Herbert, 1993), and as a result, many organizations advocate for providing a diversity of blooming forage throughout the year.

Currently, about 60% of the world's ecosystems are being degraded or used unsustainably (Millenium Ecosystem Assessment, 2005). Shifts away from land-use features that are beneficial to pollinators, such as providing access to pollen and nectar resources, has raised concerns regarding its effects on pollinators (Smart et al., 2016). Honey bee populations have shown long-term declines in populations (National Resource Council, 2007). As a result of the decline and importance of

pollinators, multiple organizations have formed to help protect and improve pollinator populations.

While there is an increasing amount of research on honey bees and ways to ensure their long-term survival, not all of this information makes its way to the beekeeper (Apis Information Resource Center, 2020). Research journals are notoriously difficult to read and are often blocked by paywalls. Many beekeepers find information from books on beekeeping. Books provide good information, but it can be difficult to find and interpret situationally and locally relevant information to address bee health issues. In recent years, many beekeepers have engaged in online forums and social media sites to find and learn information from fellow beekeepers. Some of the information shared between beekeepers in forums and social media is based on "wives' tales" and is not science-based. For example, some beekeepers decide not to treat their hives under the guise that their bees will evolve resistance against *Varroa* mites. In reality, neglecting to treat for *Varroa* leads to colony death by decreasing immunity of honey bees as a result of *Varroa* infestation (Yang & Cox-Foster, 2005), impairing honey bee development (Bowen-Walker & Gunn, 2003), and introducing viruses (Kang et al, 2016). Also many other non-*Varroa* caused diseases and other pests that need management are detrimental to bee colony health. Poor or neglectful management of pests and disease can lead to colony death. There are social media groups dedicated to encouraging beekeepers to not manage their honey bees. Therefore, we need to ensure that beekeepers have access to reliable sources of science-based information and science-based educational programming.

Previous literature notes that beekeepers tend to be adults who are learning in an informal environment. They are also easily discouraged from learning about beekeeping if they feel that it is too hard for them (Adams, 2016). As a result, beekeepers prefer learning from other beekeepers who can relate to their experiences (Adams, 2016). However, the beekeepers who are providing the education to newer beekeepers need the proper support (time, educational materials, etc.) to be able to provide a decent education (Adams, 2016). If beekeepers are relying on inaccurate, bad, or irrelevant information, potentially accessed online or even through older beekeepers, then their bees will suffer as a result of poor management (Sperandio et al., 2019). Therefore, we need to ensure that beekeepers have ways to reliably educate themselves with science-based information.

Assuming that women beekeepers may want their own learning space, and beekeepers in general need access to a science-backed education, the Center for Rural Affairs (CFRA), the University of Nebraska-Lincoln Bee lab and Entomology Education lab developed the program "Honey Bees on the Farm: Connecting Women Beekeepers and Women Farmers for Environmental and Economic Benefit." This program's goal is educating women beekeepers on how to develop beekeeping enterprises and improve their beekeeping practices. As the focus of the program was on engagement between women participants, we used learning circles as a way to network beekeepers and provide a comfortable educational setting for women beekeepers. Multiple studies demonstrate that farmers who belong to a "farm group" are more likely to adopt innovative management practices than those who

do not (Carlisle, 2016; Lugnot & Martin, 2013; Rimi & Chudi, 2017). High levels of engagement and collaboration with participants is important in increasing knowledge (Druschke & Seltzer, 2012; Sponarski et al., 2016) and changing attitudes (James, 2002; Steyaert et al., 2007). Therefore, we wanted to examine how the informal learning environment (learning circles) involving beekeepers, landowners, and experts impacted the implementation of science-based beekeeping practices. The goal of this study is to examine how participating in this program impacted participant knowledge, self-efficacy, management, and colony health.

This chapter explores research question 1 (RQ1): How does involvement in the Women in Beekeeping program impact participants? To answer the first question, we ask four sub questions (SQ): (SQ1) how does involvement impact knowledge, (SQ2) how does involvement impact self-efficacy, (SQ3) how does involvement impact bee management, and (SQ4) how does involvement impact colony health? Mixed Methods studies are composed of quantitative (RQuan) and qualitative (RQual) questions, whose data are integrated and explored with mixed methods questions (RQMM). These research questions are as follows:

SQ1: how does involvement in the Women in Beekeeping program impact knowledge?

RQuan: Do their knowledge scores increase, decrease, or stay the same over time?

Tools to examine this question: survey questions regarding knowledge.

RQual: What areas of knowledge are changing?

Tools to examine this question: themes from interview responses that

indicate what knowledge (e.g. honey bee biology knowledge, pest knowledge, landscape knowledge, etc.) is changing

RQMM: How do the knowledge survey questions confirm the findings in the qualitative data?

SQ2: How does involvement in the Women in Beekeeping program impact self-efficacy?

RQuan: Do their self-efficacy scores increase, decrease, or stay the same?

Tools to examine this question: self-efficacy scale on the survey

RQual: What actions are they exhibiting to indicate potential changes in self-efficacy?

Tools to examine this question: interview responses, video behaviors

RQMM: How does the self-efficacy scale confirm the findings in the qualitative data?

SQ3: how does involvement in the Women in Beekeeping program impact honey bee management skills?

RQuan: Do their management scores on the survey increase, decrease, or stay the same?

Tools to examine this question: survey questions regarding management

RQual: What actions are they exhibiting to indicate potential changes in management?

Tools to examine this question: interview responses, video behaviors

RQMM: How do the management survey questions confirm the qualitative findings?

SQ4: how does involvement in the Women in Beekeeping program impact colony health?

RQuan: Do their hive scores increase, decrease, or stay the same?

Tools to examine this question: hive inspection scores

RQual: How do their views of colony health change over time?

Tools to examine this question: interview responses

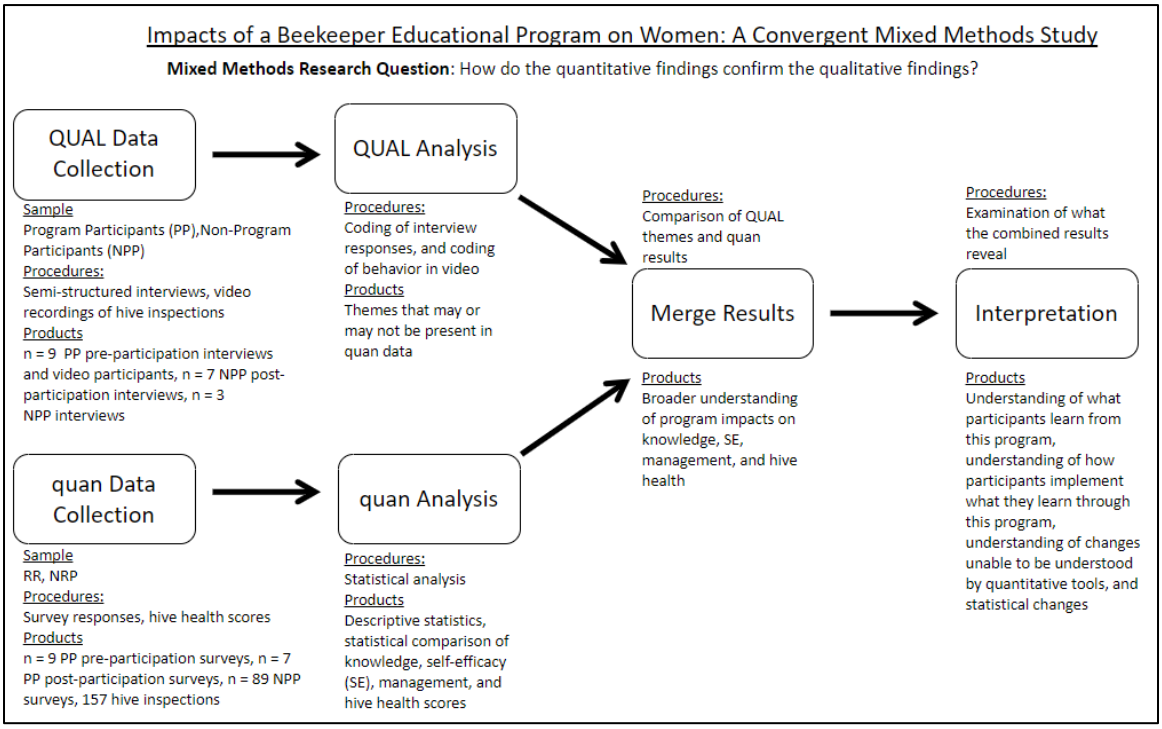
RQMM: How do their hive inspections scores confirm the qualitative findings?

Methods

I used multiple tools to answer the research questions: surveys, interviews, video recorded hive inspections, and colony health scores. Additionally, I used a convergent mixed methods design, where quantitative and qualitative data is collected and analyzed simultaneously (Creswell & Poth, 2018). My procedural diagram, a diagram demonstrating how and when data collection and analysis took place (Plano Clark & Ivankova, 2016), is found below (Figure 2.1).

Figure 2.1

Procedural diagram of this study



Note. I utilized a convergent mixed methods design and used elements of phenomenology in the qualitative analysis. Program participants (PP) are those that participated in the Women in Beekeeping program, and non-program participants (NPP) are those that did not partake in the Women in Beekeeping program. SE stands for self-efficacy.

Rationale for Mixed Methods Research

This research project employs mixed methods research for examining the first research question (Q1) (See **Appendix B** for my full definition of Mixed Methods). I chose this approach to enhance the validity of my data. The purpose of using mixed methods was to, (a) use quantitative data to support/not support the qualitative

findings, (b) look for themes across the quantitative and qualitative data sets, and (c) achieve triangulation, and complementarity of the data. Triangulation occurs by directly comparing quantitative and qualitative data for convergent and divergent results in order to obtain more valid conclusions (Plano Clark & Ivankova, 2016). Complementarity is used to obtain a more thoroughconclusion by using quantitative and qualitative data to get complementary results (Plano Clark & Ivankova, 2016). Ideally, quantitative data will be used to corroborate, or not corroborate, the qualitative findings in regard to research question 1.

Legitimation

Legitimation is a continuous process of evaluation of mixed methods procedures to ensure that one is drawing accurate conclusions and interpretations from their research. In other words, legitimation is the mixed methods equivalent to data validity. I consider legitimation to be a continuous, dynamic, iterative process and not a single step in the mixed methods process. Multiple different types of legitimation exist; however, I chose to focus on the nine typologies outlined by Onwuegbuzie and Johnson (2006). Within those nine typologies, I specifically implemented inside-outside legitimation and multiple validities legitimation within the research.

Inside-outside legitimation is the extent to which the researcher accurately presents and utilizes the insider's (emic) and the researcher's or observer's (etic) views in understanding the phenomenon. The researcher also has to appropriately balance the emic and etic views so that quality inferences and interpretations of the

mixed data can be made (Onwuegbuzie et al., 2011). Given that I have used elements of phenomenological research, a type of qualitative research focused on describing participant's experiences, in the coding and analysis of the qualitative data, there is a heavy focus on describing the emic views of the data. I want to uplift the voices of the program participants and describe their experiences, while also providing the interpretation of a researcher. Using both the emic and etic points of view, I plan to make recommendations on how to improve educational programs for women beekeepers. By focusing on the emic view in data collection and analysis, and the etic view in data interpretation, I hope to successfully balance the two in providing accurate mixed methods inferences from the data.

The primary type of legitimation that was employed throughout this research is multiple validities legitimation. This type of legitimation focuses on addressing the legitimation (or validity) of the quantitative and qualitative data to ensure appropriate conclusions and inferences are drawn from the quantitative and qualitative data as well as the mixed results (Onwuegbuzie & Johnson, 2006; Onwuegbuzie et al., 2011). To ensure quantitative validity, I worked closely with a statistician in the statistical analysis of the data. Given that some of the sample sizes were small (program participant post-survey, n = 7) and I compared unbalanced sample sizes (non-program participants, n = 89), I, in conjunction with the statistician, spent time examining different statistical tests that could appropriately examine data sets with these sample sizes.

Furthermore, I employed two different validation methods within the qualitative data: bracketing and use of multiple coders (Creswell & Poth, 2018).

Bracketing is a process whereby the researcher acknowledges their own previous experiences and preconceived notions in an attempt to prevent biasing of the data (Litchman, 2013). This was done to ensure that I was capturing the emic view, and not incidentally putting my own biases into the data. Additionally, this research was initially coded by multiple researchers. The video recorded hive inspections were initially coded by four different researchers. The interviews were coded by one researcher, but the interview codes and themes from this data were examined by two other members of the research team. This data was then discussed amongst the research team to reach consensus that I was accurately interpreting the data.

I have outlined specific mixed methods questions regarding this research as a way to guide the mixing of the data. This is done to make sure I am purposely mixing the quantitative and qualitative data. By ensuring quality quantitative and qualitative data, I feel confident that the mixed data is also of quality. In using these two strands of legitimation, inside-outside legitimation and multiple validities legitimation, I hope to draw accurate conclusions from the quantitative, qualitative, and mixed data.

Participant Recruitment

Nine beekeepers who participated in the Women in Beekeeping program were followed for an entire beekeeping season (March to October). These women are also referred to as program participants, as defined in Chapter 1. Purposive sampling is a sampling technique where participants are selected based on a set of predefined criteria for the research (Creswell & Poth, 2018). This sampling technique was used

to select participants that identify as a woman, keeps bees, and participates in the Women in Beekeeping program. Program participants were recruited to join the Women in Beekeeping program and this research project through the Nebraska Beekeepers Association, social media posts, and personal contacts. The program participants are described below. One beekeeper dropped out of the study during the course of the beekeeping season.

The Beekeepers

The names listed below are pseudonyms for each program participant. Pseudonyms were used for all data collection and analysis. These are the names I use for the participants throughout this thesis.

Beekeeper 1: Janet

Janet is a hobbyist beekeeper from Central Nebraska. She is in her early 50's, and 2019 was her third season keeping bees. Janet took a beekeeping course prior to buying her honey bees, and still relies on her mentor from that course. She primarily keeps top bar hives, which are different than the standard Langstroth hive. The top bar hive box is typically one height, and the bees move lengthwise throughout the colony, instead of moving upwards or downwards as in the Langstroth hive (Figure 2.2). Additionally, she has two hive bodies that are longer Langstroth boxes, commonly known as "Long Langs." Since top bars are not standard made, Janet uses foundationless frames. Winter 2018/2019 (fall 2018-spring 2019) was the first winter she successfully overwintered bees. Janet lives and works on a large family

farm, keeping cattle and planting corn. She is the primary beekeeper as her husband, who also works on the farm, does not typically help with her honey bees. However, her husband is supportive of her venture, as he built her hive bodies. Janet's son does help with her honey bees from time to time, and bought his own hives in 2019. Her son keeps standard Langstroth hives.

Figure 2.2

Top bar hives

Note. Starting in the upper left corner, going clockwise, there is a side view of a top bar hive, a frame from a top bar hive being held upside down for inspection, and two top bar hives at one apiary.

Beekeeper 2: Kristin

Kristin is a hobbyist beekeeper from Southeastern Nebraska. She is in her late 20's, and 2019 was her second year keeping bees. Kristin works a full-time desk job during the winter and runs her own organic vegetable farm during the summer. She learned beekeeping from a former boss who also kept bees, and eventually bought her boss' bees. Her bees are kept on her parents' property near her vegetable farm. Her hives and vegetable farm are surrounded by conventional crops on all sides, the fields are planted with either soybeans or corn, depending on the plot of land and year. She is the primary beekeeper, although she does receive occasional help from her boyfriend, who also keeps bees, and a mentor beekeeper that is in her area. Kristin keeps standard Langstroth hives (Figure 2.3).

Figure 2.3

Three standard Langstroth hives

Note. These hives each have two deep boxes. This is a standard set-up for the state of Nebraska.

Beekeeper 3: Fiona

Fiona is a hobbyist beekeeper from Eastern Nebraska. She is in her late 30's, and 2019 was her second year beekeeping. She has taken a beekeeping course through the University of Nebraska-Lincoln Bee Lab prior to joining the Women in Beekeeping program and works with a mentor beekeeper in her area. Fiona and her husband keep a small vegetable patch, and both work full-time jobs. Her bees are kept on her land. She is the primary beekeeper. Fiona keeps standard Langstroth hives.

Beekeeper 4: Julia

Julia is a former hobbyist beekeeper from Eastern Nebraska. She is in her mid-60s. 2019 was the third year of her husband keeping bees, but the second year of her helping her husband keep bees. Julia works full-time and keeps bees on friend's land. Her husband is the primary beekeeper. 2018 was the first year Julia started helping with the bees. Julia does not take a particular interest in keeping bees. She often states that she prefers to, "just watch her husband." Both Julia and her husband have both taken beekeeping courses through the University of Nebraska-Lincoln Bee Lab prior to their involvement with the Women in Beekeeping program. Unfortunately, in 2020 Julia had an allergic reaction after being stung. While her husband still keeps bees, she no longer assists him. Julia and her husband keep standard Langstroth hives.

Beekeeper 5: Donna

Donna is a hobbyist beekeeper from Eastern Nebraska. She is in her mid-60s, and 2019 was her eighth year keeping bees. She is retired but works a few part-time jobs and volunteers in her town. Donna has three apiaries; two that are kept off of her property and one at her house. All of her apiaries are in Eastern Nebraska and within close driving distance of her home (less than a 30-minute drive). I inspected one of her apiaries not on her land. She took one beekeeping course twice, prior to having bees and after she started keeping bees. She is the primary beekeeper of her apiary, although she does have a few friends that occasionally help her. Donna keeps standard Langstroth hives.

Beekeeper 6: Justine

Justine is a hobbyist beekeeper from Central Nebraska. She is in her early 20's and 2019 was her fifth year keeping bees. She first started beekeeping as part of the Nebraska Beekeepers Association scholarship program. She helps run and teach a number of beekeeping workshops prior to, and while involved in, the Women in Beekeeping program. Justine is a full-time undergraduate student at a school in Eastern Nebraska and often travels back to Central Nebraska to keep her bees. She is the primary beekeeper, but her mother helps with her bees while she is away at school. Justine has two apiaries, one at her parent's house and another on a farmer's outside of her hometown. I inspected the apiary outside of her hometown. Justine keeps standard Langstroth hives. While Justine is classified as a hobbyist as she has few hives, she does run a small business selling comb and regular honey.

Beekeeper 7: Margaret

Margaret is a hobbyist beekeeper from Eastern Nebraska. She is in her late 40's and 2019 was her first year keeping bees. Her daughter started beekeeping as part of the Nebraska Beekeepers Association scholarship program. Margaret helps her daughter beekeep. During Margaret and her daughter's participation in the Women in Beekeeping project, they also took a number of courses from the Nebraska Beekeeper Association and University of Nebraska-Lincoln Bee Lab. Margaret works full-time but keeps a number of small, planted flower and vegetable patches around her home. Her daughter does most of the beekeeping. However, Margaret and her

daughter make management decisions as a team. They keep their bees in Langstroth hives on their property.

Beekeeper 8: Sam

Sam is a hobbyist beekeeper from Eastern Nebraska. She began this program, but dropped out about halfway through due to other commitments. Thus, data from her participation was not used in this study.

Beekeeper 9: Amelia

Amelia is a hobbyist beekeeper from Eastern Nebraska. She is in her mid-30's and 2019 was her ninth year keeping bees. She works full-time. Amelia and her husband also run a small business making products from beeswax. Both Amelia and her husband took a beekeeping course before getting bees. Now they help teach beekeeping workshops and are on the board for the Nebraska Beekeepers Association. They have mentored multiple students through the Nebraska Beekeepers Association Scholarship program and had a mentee in 2019. Amelia's husband is the primary beekeeper. They make joint decisions regarding the management of their hives. They keep a few apiaries on friend's and family's properties. They keep standard Langstroth hives.

Beekeeper 10: Rosemary

Rosemary is a hobbyist beekeeper from Central Nebraska. She is in her late 30's and 2019 was her fourth year keeping bees. She is a self-employed work from home

mom and works on her small farm with her husband. Prior to owning bees, she took a formal beekeeping course. Now she is an active member of the Nebraska Beekeepers Association and was a mentor for the beekeeping scholarship program in 2019. She is the primary beekeeper. Her bees are kept on her property. She keeps standard Langstroth hives.

Learning Circles

A learning circle defines a group of people, for example: health care workers, elderly patients, or in this case women beekeepers and landowners, who meet regularly over a period of time to discuss and learn about a topic. Some common characteristics of learning circles are:

- A group of 8-10 people
- Meets regularly
- Led by a facilitator
- Encourages growth and learning
- Has a set of learning objectives (Keane, 2016).

Learning circles typically occur over 7-9 sessions, each session lasting from thirty minutes to two hours (Keane, 2016). As the name suggests, when groups meet in person they meet in a circle. The Learning Circle facilitator provides a talking prompt, and then each person in the circle will be given a turn to say something about the prompt. These presentations are followed with open discussion time. During some sessions, presenters from outside the CFRA and UNL were invited to talk about a topic of interest.

The Women in Beekeeping program had the goal of creating a network of women beekeepers and landowners. While the program was aimed at women, men were also allowed to attend. The goal of the learning circles was not to create a men-free space, but rather to create a women-dominated space. This means that most of the learning circles participants were women, and that the program was advertised specifically as a space for women. The learning circle facilitator aimed to make these learning circles as informal as possible, providing very little structure to the learning circle. Participants were able to suggest topics for future learning circle sessions, but topics were ultimately selected based upon the availability of resources and popularity with beekeepers and landowners.

Learning circles were held within the state of Nebraska (Table 2.1). Due to the distance between towns and winter weather, some learning circles were held online over Zoom, a video conference program, to reach a wider audience. Some lives sessions were also live streamed over Zoom, depending on the location and topic. Learning circles held over Zoom were video recorded and made available for viewing on social media sites. Fiona and Janet were the only program participants to mention using the Zoom recordings and stated that they would go back and rewatch the Zoom recordings to catch information they missed. In total, 71.43% (5 of the 7) of the learning circles had at least one program participant in attendance. Donna was the only program participant to not attend a learning circle session to my knowledge, but was signed up for the program.

Table 2.1

List of learning circles offered through the Women in Beekeeping program in 2019

Month	Learning Circle Topic	Organization Providing Content
January	Value Added Products	Over Zoom with University of Nebraska-Lincoln (UNL) Bee Lab
February	Planting for Pollinators	Over Zoom and in-person with Nebraska Statewide Arboretum
March	Setting up Secondary Location	Over Zoom with UNL Bee Lab
April	Land Contracts	Legal Aid of Nebraska
May	No learning circle	
June	Touring a Prairie	Prairie Plains Resource Institute
July	No learning circle due to farm season	
August	No learning circle due to farm season	
September	Seeds for Pollinator Plantings	Stock Seed Farms
	Touring a Secondary Apiary Location	CFRA and Fox Run Farms

Surveys

Surveys were administered to program participants prior to their involvement with the Women in Beekeeping program and then at the end of the beekeeping season in Nebraska (October). They were given the same survey both times. Two beekeepers, Justine and Amelia, did not complete a post-participation survey. Additionally,

surveys were administered to non-program participants. Non-program participants were recruited through multiple social media pages. The only criteria for non-program participants was that they identify as a woman and actively keep bees. Program and non-program participants received the same survey. Both surveys were administered online through Qualtrics™. The questions aimed to capture basic demographics, knowledge, management strategies, views of colony health, and self-efficacy.

I developed questions to measure the knowledge and management levels of beekeepers. For knowledge, I asked questions regarding general pollination and honey bee knowledge. For management knowledge, I asked questions regarding their management of honey bees and wild pollinators. Questions were created based on the topics expected to be covered by the Women in Beekeeping program. To quantitatively assess their responses, I created a framework of the themes that arose from the participant responses and then assigned a score to these themes.

A self-efficacy scale was created for this survey. The interest in self-efficacy (SE) stems from the concept that the program's education will influence the beekeeper's belief that they can successfully keep bees. People with high self-efficacy are more likely to successfully complete a task (Schunk, 1984). Under this assumption beekeepers with higher self-efficacy are more likely to be successful in their beekeeping ventures.

A self-efficacy scale was used because self-efficacy can only be measured by the individual. Self-efficacy scales are highly tailored to the topic at hand in order to ensure that they accurately predict self-efficacy (Bandura, 1986). Therefore, I

cannot use another's scale, nor did I find a self-efficacy scale directly related to beekeeping. The scale created for this research aimed to encompass three of the four main influences of SE: performance attainment, physiological or emotional state, and verbal persuasion (Bandura, 1986). I did not examine "vicarious experiences" (Bandura, 1986), as the program did not provide instances where beekeepers would watch someone else complete a task with which they could compare themselves. Additionally, vicarious experiences are difficult to measure, as it is difficult to tie specific experiences of watching someone else complete a task to self-efficacy and is not a relatively dependable source of self-efficacy (Bandura, 1977). Rather, the research team decided to examine the three influences that we believe the Women in Beekeeping program aimed to cover. In creating this scale, I referenced the methods and questions of a number of articles and used this to develop my own self-efficacy scale (Bandura, 2006; Holmes, 2016; Klassen, 2002; Pajares, 1996; Schneider - Cline, 2015; Wuepper, Zilberman, & Sauer 2019). Past SE scales examining farmers used mastery experiences of skills and emotions regarding farming as proxies for SE (Wuepper, Zilberman, & Sauer 2019). Given that beekeeping is related to agriculture, measures similar to these were included to determine beekeeper self-efficacy.

The following is how we outlined the self-efficacy scale:

- Phrases regarding beekeeper management and bee knowledge are considered to fit into the category of "performance attainment," as it is likely that participant's feelings about these topics will be related to their past experiences regarding knowledge and management.

- To measure physiological state, or emotion, participants were given a list of emotions and had to rank how well those emotions describe them while beekeeping.
- Furthermore, beekeepers were asked to compare themselves to other beekeepers, which provides a measure of verbal persuasion.

The self-efficacy scale focused on knowledge and management factors (e.g. how confident are you overwintering 70% of you bee colonies, how certain are you that you can identify the different stages of bee development, see **Appendix C** for the complete self-efficacy scale) because the Women in Beekeeping program aimed to improve participant's knowledge and management strategies. To measure changes over time in participant's perceived abilities regarding these topics, the scale was tailored to these potential changes. I used "can" or "certainly" phrases in a Likert scale in the writing of the questions, to accurately capture beekeeper's SE without indicating that I was measuring SE (Bandura, 2006; Schneider-Cline, 2015). The SE scale can be found at the end of **Appendix C**, questions 30-33.

Hive Inspections

To examine how beekeeper management changed over time, I accompanied program participants when they inspected their hives. During these sessions, I video recorded inspections and took notes on colony health. The goal was to look for potential changes in management and hive health over time.

First, I aimed to inspect the hives with the beekeeper once every four to six weeks starting in March and ending in late October. Each beekeeper walked me

through an inspection of their hives while I recorded their inspection on video. Each program participant participated in at least 4 hive inspections, with the maximum being seven session. Unfortunately, some early season inspections were cancelled because program participants did not receive their packages or were not able to access their bees in the early season due to the 2019 Nebraska floods. Drops in temperature in October meant that many of the late season inspections were canceled or rescheduled.

During these inspections I wore a GoPro Hero 4, a white body harness, and an attachable microphone (Figure 2.4). The microphone also had windscreens to reduce excess noise. Inspections lasted between 20 and 150 minutes. I inspected the same hives each time I visited. For beekeepers that ran multiple apiaries, I asked them to limit inspections to one apiary.

Figure 2.4

GoPro set-up used to video record hive inspections

Note. The attachable microphone is not pictured here.

To better understand if their management changed, and reduce researcher influence on the beekeeper, I asked beekeepers to conduct the inspections. This means they dictated which colony that they inspected first, time of day, under what weather conditions to inspect, and when to stop inspecting the hive. While the initial intent was to only observe during inspections, participants asked me questions about management of their hives. For example, a number of program participants asked me to demonstrate how to appropriately test and treat for *varroa*. In the interest and spirit of providing beekeepers the best learning experience, the research team decided that I would become a more active participant during inspections, answering beekeeper questions. This approach of actively positioning the researcher is akin to ethnographical qualitative research. Ethnographical

research involves examining a culture sharing group, and as a result, the researcher is often embedded and actively involved with the research participants (Creswell & Poth, 2018). Where possible I placed analytical focus on the emic (participant) perspective to reduce potential researcher bias (Creswell & Poth, 2018). This means that to reduce researcher influence on data collection, our conversations while beekeeping were fully directed by the beekeepers. Using an example of testing for *Varroa* mites, I only tested for V*arroa* with beekeepers who specifically asked me to assist in this activity. On the other hand, this meant that if I saw an example of less than ideal honey bee management, I did not provide help or alert the beekeeper of this problem (Figure 2.5). Many beekeepers used me to physically help with the hive inspection, such as inspecting hives with bad tempers, removing boxes, and switching equipment. Additionally, beekeepers used my presence to discuss and demonstrate different management options, such as having me confirm the presence of pests, eggs, and the queen in the hive or discuss the pros and cons of different miticide treatments.

Figure 2.5.

One example of an unnecessary beekeeping technique

Note. Some beekeepers will stagger their boxes to increase air circulation within the hive. However, this technique is rather ineffective as the honey bees will fill the open space with propolis, reducing any effect of the box staggering. The beekeeper did not state a reason why she wanted to increase air circulation within the hive. While unnecessary, this practice does not particularly hurt honey bees.

I utilized video recordings because videos can be watched multiple times, allowing for better documentation of how events unfold over time, body language, interactions with the hives and other objects in the area (Jewitt, 2012). After the inspection was finished, videos were uploaded to a cloud-based service to accommodate for the large video files. The GoPro firmware automatically splits the

recorded files into 17 minute and 43 second long videos. Therefore, videos were uploaded as different "chunks." These videos were all password protected and labeled with the beekeeper's pseudonym.

The initial coding took place with a subset of edited videos. Coding is a process of categorizing what is in the data, with initial coding being the first attempt at arranging and categorizing the data (Saldaña, 2013). These videos were randomly selected from completed inspections. I and other research team members participated in three initial rounds of coding. During each round we coded a different set of videos, looking for beekeeping behaviors. Through initial coding discussions we decided to classify beekeeper behaviors as "experienced" or "inexperienced" practices. After the second round of coding, we decided to use process coding as a coding technique. Process coding is a type of coding that uses gerunds to connote actions (Saldaña, 2013). It is typically used in grounded theories, but we used it for this research since we wanted to extract what actions the participants were performing while beekeeping.

After this initial coding, I began the process of bracketing. This is typically used in phenomenological research. Phenomenology is a type of qualitative research aimed at expressing and lifting up the voices of participants. Therefore, I needed to reduce my outside biases during the process of coding and analysis of those codes. Bracketing is where the researcher acknowledges their own biases and attempts to set those biases aside in analysis of the data (Moustakas, 1994). While some argue that bracketing cannot happen as we cannot truly set aside our biases (Van Manen, 1990), for this research it is important to acknowledge and attempt to set aside and

reflect on these biases. Prior to the coding process I began the process of bracketing, and continued to acknowledge my biases throughout the coding process. I have been a bee researcher since 2016. This means that I have my own experiences and preconceived notions on beekeeping actions. Therefore, prior to coding data I made a list of my own preconceived beekeeping notions. This list included certain techniques that I prefer but may not necessarily influence the beekeeper's management. For example, I typically prefer and encourage beekeepers to not wear gloves while beekeeping. I had to set aside the notion that wearing gloves is an acceptable practice for beekeepers. Using this information prior to data coding, I took part in a reflective meditation where I attended to my prior beekeeping experiences and actions, similar to the process described by Creswell and Moerer-Urdahl (2004).

Each visit, the program participant and I inspected at least two hives (except Margaret, who only owned one hive). I randomly selected an inspection from each visit to code. Only the actions of the program participants were coded. I coded one inspection per visit for each beekeeper and reached saturation of generating new codes early on in the coding process. However, I wanted to ensure that I captured actions from all of the program participants. Therefore, I continued to code these videos. While no new codes were found, it helped me to confirm that I reached saturation.

Once the list of codes was generated, I began to horizontalize the data. This means that each piece of data is treated as equal, no amount of data is created as more or less significant than the other (Moustakas, 1994). Therefore, during coding,

each action was coded and treated as equal, creating a horizon of data. I was then able to eliminate repetitive or overlapping codes (Eddles-Hirsch, 2015; Moustakas, 1994). I began the process by looking at the entire list of codes as a group. Two themes naturally emerged when viewing the codes as one entity: experienced beekeeping and inexperienced beekeeping actions. Inexperienced actions are those that are expected to be performed by a beginner beekeeper. For example, "brushing bees wrong way," "dropping edges of the frame," or "rolling frame." Experienced actions are actions that are expected from experienced or practiced beekeepers. While these actions are not specific to beekeepers that have been keeping bees for a long time, they are actions that are commonly accepted as "good" actions among beekeepers. These include "smoking bees," "cracking frames," or "putting lid back on hive." Once I divided the codes into these groups, I started looking for emerging themes within these actions.

To ensure the validity and rigor of the video inspections, I employed two different validation methods (Creswell & Poth, 2018): bracketing and multiple coders. Bracketing is a process whereby the researcher acknowledges their own previous experiences and preconceived notions in an attempt to prevent biasing of the data (Litchman, 2013). Additionally, these videos were initially coded by four researchers, and the codes generated by all four researchers were used.

Second to be discussed, are the methods for scoring hive health. A standardized note sheet was used to record factors such as bee population, brood pattern, queenrightness, presence/absence of diseases/pests, demeanor of the colony, as well as any other notes from the beekeeper such as splitting the colony

prior to inspection (see **Appendix A**). I took notes on the same hives each inspection. After each inspection, the notes were transcribed into an Excel sheet and sent to the beekeeper.

To determine the health of the hives and the potential impact on beekeeper management, a scoring sheet was developed based on a colony inspection sheet used by the UNL Bee Lab (UNL Bee Lab, 2018). This sheet is based on observable, seasonal hive health indicators (e.g. brood patterns, presence of bee life stages, population, food stores, and presence of disease and parasites). I then modified this sheet to be able to assign a health score to each hive. Using the UNL Bee Lab sheet, a standardized scoring system based on observable hive health indicators was developed. To pilot this sheet, the research team went through multiple rounds of scoring the hives and adjusting the scoring system until we felt comfortable that the sheet was accurately scoring hive health. The score is initially based on the population of the hive and time of year the hive inspection took place. Points are then added or subtracted based on what was recorded within the hive for that time of year. These measures include finding eggs, brood pattern, pests, etc. (see **Appendix D** for the full list of measures that were used). To ensure the sheet was providing accurate results, two members of the research team randomly scored the hives without the scoring sheet. An analysis of the interrater reliability of the raters' scores was conducted and found to have an acceptable reliability (Crohnbach's alpha: 0.797). Additionally, there was acceptable reliability between the scoring sheet itself and the two scorers (Crohnbach's alpha: 0.905). Since I found acceptable reliability, I used the sheet to provide a health score for the inspected hives.

Interviews

Program participants took part in at least two interviews, with the possibility for a third follow-up interview. All program participants took part in the first two interviews. These two interviews were a set of pre- and post-program involvement interviews. The goal of these interviews was to gather data regarding hive management, pollinator knowledge, self-efficacy, beekeeping experiences and usefulness of the Women in Beekeeping program. See **Appendix E** for the full list of interview questions.

Pre-program interviews were conducted prior to the participants involvement in the 2019 Women in Beekeeping program. Interviews lasted from 30 and 60 minutes, with an average time of 35.5 minutes. Interviews were recorded on a hand-held voice recorder. After the interviews, audio files were uploaded to a password protected cloud storage service and assigned a pseudonym. Pseudonyms for the beekeepers were kept consistent throughout the entire project. Audio files were then submitted to Temi for transcription (temi.com). Transcripts were then checked for accuracy and uploaded to MaxQDA (Verbi Software, 2018) for coding.

The post-program interview was conducted at the end of the beekeeping season. These interviews were conducted in October and November of 2019. Participants were asked the same questions as they were in the first interview with additional questions regarding their experiences in the Women and Beekeeping program (**Appendix E**). Interviews lasted for an average of 44.21 minutes. The goal of the second interview was to measure how the participant's knowledge,

experiences, and self-efficacy may have changed over the course as a result of the program and for program evaluation purposes.

Participants were given the option to complete a third, follow-up interview. These interviews were completed in January and February of 2020. Interviews lasted approximately 20 minutes and were completed over the phone (see **Appendix F** for the interview questions). A voice recorder was used to record the conversation. Three Research Participants took part in the follow-up interview: Janet, Fiona, and Rosemary.

Three non-program participants also participated in interviews. These non-program participants were from Kansas and Iowa which have comparable climate, weather, and bee stressors requiring management practices similar to those in Nebraska. Each interviewee was assigned a pseudonym (Georgia, Eleanor, and Olivia). I recruited beekeepers who had comparable years of beekeeping experience to the program participants. Non-program participants were given the same interview that program participants post-involvement in the Women in Beekeeping program. Questions regarding the specifics of the program were excluded from the interview, excluding a total of two interview questions. These interviews were conducted in person.

As in the video coding methods, I began the process of coding by attempting to bracket my biases. I used values coding and in-vivo coding to capture the essence of the participant's values, attitudes, and beliefs. Values coding is typically used in studies that explore cultural values, identity, and personal experiences, by coding

segments as either an attitude, value, or belief (Saldaña, 2013). These are loosely defined:

- Values: the importance we attribute to something or the greater personal meaning.
- Attitudes: the way we think and feel about ourselves, another person, thing, or idea; essentially someone's opinion.
- Beliefs: our personal, embedded values; a value or attitude plus our personal knowledge, experiences, opinions, prejudices, morals, and other interpretive perceptions of the social world (Saldaña, 2013).

These three definitions are not mutually exclusive, as some individual codes encompassed both a value and belief, or attitude and value. I also used in-vivo coding in addition to values coding. In-vivo coding involves using the participants language for codes (Saldaña, 2013), for example "they're emotionally closer to me" or "probably diseases or mites." I did this as a way to ensure that I am capturing the participant's feelings and essence and also to avoid imparting my own biases onto the codes. All interviews were coded using the methods described.

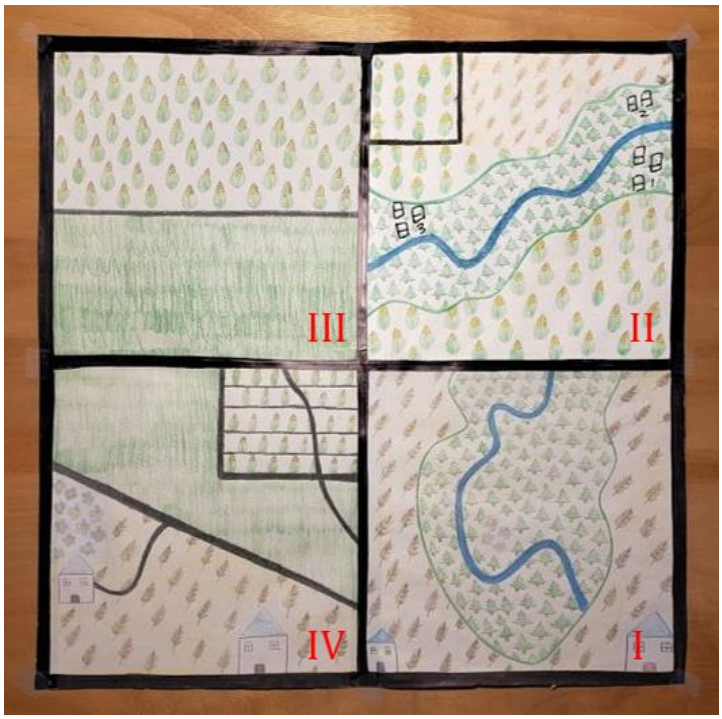
After all the interviews were coded, codes were then entered into a spreadsheet to examine differences prior to and after participation in the program. I also compared the program participant codes to the non-program participant codes. From this sheet, I was able to generate different themes that emerged from the data.

Landscape Map Question. Question five of the interview asked participants about a series of maps (See **Appendix G**). For this question, I gave participants a series of scenarios with an accompanied map and asked them to place an apiary on

the map (Figure 2.6). I asked the beekeepers to place apiaries in four different scenarios. The goal of this tool was to assess what beekeepers are looking for in apiary placement, such as food resources, water sources, and terrain.

Figure 2.6

Image of a map for the landscape map question



Note. The quadrants are numbered in red, going counterclockwise starting in the bottom right corner. The black box in quadrant II was drawn by a beekeeper during a pilot interview in response to Scenario II.

Limitations

The difficulty of conducting mixed methods research is that the sample sizes for quantitative and qualitative research differ drastically. In quantitative research,

statisticians will conduct a power analysis to determine the smallest possible sample size. Researchers then hope that they can meet this sample size, with many researchers aiming to have a sample size of one hundred or more. However, within the realm of qualitative research, it is rare to see a sample size larger than ten. Describing the lived experiences of one hundred participants would be overwhelmingly time consuming. A phenomenological study typically has fewer than ten participants, but this can vary based on the research question (Creswell, 2013; Padilla-Diez, 2015). Qualitative work utilizes fewer participants than quantitative work because of the amount of work required to code, horizontalize, and then create themes from qualitative data. Additionally, in phenomenological work, where the goal is to describe a participant's experience, one can better describe an individual's experiences when there are fewer participants. A mixed methods project has to balance this struggle of sample size and aim to satisfy the requirements of both quantitative and qualitative research. There is a limitation on the quantitative portion of this research due to the small number of program participants (n=9).

Given the time restraints of a Master's program and the seasonality of beekeeping, there are limits to what I can conclude about the impacts of this research program. I followed program participants for one beekeeping season (March-October of 2019). In an attempt to account for potential long-term impacts of the program, follow-up interviews were conducted in January and February of 2020. As a result, I was unable to measure long-term impacts of the Women in Beekeeping program. Additionally, since I only followed the beekeepers for one

season, I only have a snapshot of their beekeeping experiences. Data regarding the hive scores is especially at the mercy of the weather nuances of 2019, which included a rather wet and cold spring.

I used purposive sampling methods to select participants for this project. For program participants, I wanted those identifying as a woman, keeps bees, and were willing to partake in the Women in Beekeeping program. Given that the Women in Beekeeping program attracted less experienced beekeepers, six of our nine program participants started with four or less years of experience beekeeping. This means that some of the data may be skewed towards experiences of new beekeepers. While I did not select participants based on race, the program participants were all white, cis-gendered women. This means that the data does not include the voices of Black, Indigenous, People of Color, and transgender women.

IRB Considerations

Approval for this research was obtained from the University of Nebraska-Lincoln's Institutional Review Board (Approval number: 20180818534). This study utilized women beekeepers and landowner ages 19 and older. At no time were participants pressured into engaging in the research. The ultimate purpose of this research is to understand the experiences of women beekeepers. The purpose of the study was disclosed to participants both in writing and verbally. My contact information, affiliation, participants' rights and IRB approval was provided to participants in an Informed Consent Form. A copy of the Informed Consent Form is located in **Appendix H**.

Results

Survey statistics were conducted in SAS 9.4. Hive score statistics were conducted in IBM SPSS 27. All statistical assumptions (e.g. homogeneity of variance, normal curve, sphericity) were met unless otherwise stated.

Demographics

All nine program participants completed the pre-survey and seven completed the post-survey. 160 respondents took the non-program participant survey. After removing those with incomplete surveys, male participants, and responses from those outside the United States of America, there were 89 non-program participant responses that were used in this study. The same survey was administered to the program participants and non-program participants. The non-program participants only completed the post-survey.

Program participant's background and demographic information is summarized in Table 2.2. Program participants were on average younger by 7.5 years, had fewer years of experience beekeeping, experienced a higher percentage of summer colony loss, and owned more acres of land than non-program participants (Table 2.3). The top five careers of the program participants and non-program participants are listed in Table 2.4. There was not much overlap between the careers of program participants and non-program participants. Jobs categories were classified based on descriptions provided by the United States Department of Labor (United States Bureau of Labor Statistics, 2018). Almost half of program participants and non-program participants classified honey bees as livestock, but

program participants more often thought of honey bees as wild animals or pets than non-program participants (Table 2.5). This question allowed participants to provide their own response, with some typical "other" responses being "friends" or picking two of the options, such as "wild animals and livestock."

Table 2.2

Demographics of the program participants

Pseudonym	Age (At end of program)	Years Beekeeping	Primary Beekeeper?	Highest level of education?	In which way were they influenced to be a beekeeper?	Themes in their interviews
Janet	53	3	Yes	Associate's	Family member/partner	Family, Top bar beekeeping
Kristin	29	2	Yes	Bachelor's	Friend/acquaintance	Agriculture, management struggles
Fiona	38	2	Yes	Graduate degree	How bees help me	Management struggles
Julia	67	4	No?	Associate's	Friend/acquaintance	Lack of knowledge
Donna	66	8	Yes	Graduate degree	Plight of bees	Management struggles, spirituality of beekeeping
Justine	20	5	Yes	Some college	How bees help me	Agriculture
Margaret	50	1	No	Bachelor's	Friend/acquaintance	Environment, family
Amelia	37	9	No	Bachelor's	Family member/partner	Environment, family
Rosemary	39	4	Yes	Bachelor's	How bees help me	Environment, family

Table 2.3

Comparison of program participants and non-program participants

	Mean Age	Type of Beekeeper	Years Beekeeping	Primary Beekeeper	Summer loss 2018	Winter loss 2018/2019	Acres of Land Owned	Type of Land Owned
Research Participants	43.4	Hobbyist: 9	3.67	Yes: 6 No: 3	19.6%	28.8%	772.9	Agricultural Land: 2 Acreage: 3
Non-Research Participants	50.9	Hobbyist: 87 Commercial: 1	4.29	Yes: 84 No: 5	7.9%	26.5%	28.1	Agricultural Land: 16 Acreage: 45 Non-Ag Land: 10

Table 2.4

The top five careers for program participants and non-program participants

	Careers
Program participants	1. Farming, Fishing, and Forestry (2) 1. Office and Administration Support (2) 2. Retired (1) 2. Management Occupations (1) 2. Educational Instruction and Library Occupations (1) 2. Health Care (1) 2. Personal Care and Services (1)
Non-program participants	1. Retired (26) 2. Health care (14) 3. Office and Administration Support (13) 4. Personal Care and Services (7) 4. Educational Instruction and Library Occupations (7)

Table 2.5

Responses to the question, what do you consider honey bees? Percentages represent the percent of beekeepers that gave that response

	How do you think of bees?
Pre-program participants (n=9)	Wild Animals - 40% Livestock - 40% Pets - 10% Other - 10%
Post-program participants (n=7)	Wild Animals - 37.5% Livestock - 50% Pets - 12.5%
Non-program participants (n=88)	Wild Animals - 19.1% Livestock - 43.8% Pets - 6.7% Other - 31.5%

SQ1: how does the Women in Beekeeping program impact beekeeper knowledge?

Quantitative Results. Four survey questions pertaining to beekeeper knowledge were asked: Do you know of any policies or laws that involve pollinators?; Which of the insect choices listed below are considered important plant pollinators; How do you tell if an area is good for keeping bees?; and, in as much detail as possible, describe what you look for when you inspect your hives? (see **Appendix C**, questions 17, 18, 19, and 23 respectively). A framework for scoring the responses to questions 17, 19, and 23 was developed based on response themes. Numeric scores were applied to the responses with the framework found in Table 2.6. Question 18 was scored using the framework described in Westerhold (2017). A Signed Rank Test was used to compare the total scores for questions 17, 18, 19, and 23 (range of total score: 0-16) for program participants pre-survey

(before the program) and post survey (after participating in the program). There was a marginal increase between program participant knowledge scores pre-survey and post-survey (M_{pre}= 8.67, M_{post}= 10.14, z= -3.03175, p= 0.0625). In comparing the post-participation program participant scores to non-program participants, a Wilcoxon Two-Sample test was used. Program participants had a marginally higher knowledge score (M=10.14, SD= 2.85) than non-program participants (M= 8.27, SD= 2.17; z= 461, p= 0.0762).

Table 2.6

Framework for scoring survey responses

Question	Score	Description/Attributes of Score	Examples
Do you know of any policies or laws that involve pollinators?	0	Left response blank. Not used in analysis.	
	1	Responded that they did not know of any policy/law(s). A law or policy is a principle of action or set of rules that is administered or enforced by a government.	No
			Pesticides and herbicides need to be sprayed at night so that daytime pollinators are hurt less
	2	Names a policy(s)/law(s), but does not provide a description of the implications of the reasoning for or impacts of the law/policy on themselves or others. These responses do not refer to a specific law/policy.	The Saskatchewan Apiaries Act (specifically regs for beekeepers and honey bee colony mgmt. [*sic*])
			Local ordinances regarding keeping colonies of honeybees.
	3	Names a policy(s)/law(s) and provides a description of the implications of the reasoning for or impacts of their listed law(s)/policy(s) on themselves or others. These responses refer to a specific law/policy.	State of GA DOT has a new policy asking citizens to report wild Milkweed sightings so they can be marked and protected from mowing. [*sic*]
How do you tell if an area is good for keeping bees?	0	Did not answer the question. Not used in analysis.	Observe and try to identify what you already have to see whether pollinators are visible. Once you know what you want to promote, research to find out what they need & wheather it's feasible in your area. [*sic*]

	1	Did not provide implications, results, or uses of all of the features that they listed.	Wild plants, variety of trees
			Tree cover water source wind break. Sunshine
	2	Listed the implications, results, or uses of 1-2 features, but did not provide this information for all of the features listed, or listed a misconception, incorrect information, or we were unable to understand some of the implications of the features listed within their answer.	Broad variety of plants within 5 miles, Minimum exposure to herbicides, pesticides, and GMO, water source, forested areas, native plants [*sic*]
			Good shelter and location with plenty of sun and late day shade; protected area; variety of food sources.
	3	Listed the implications, results, or uses for 3 or more of the features listed, and they do not list any misconceptions or incorrect information.	Availability of a diverse forage, ie not extensive monoculture exposure Shelter from sun and wind (here in SA, we don't struggle with extreme frosts and snow) Shelter or protection from vandals, wild animals Access to water source [*sic*]
	4	Listed the implications, results, or uses for 3 or more of features listed, and they do not list any misconceptions or incorrect information, and they mention access to diverse forage throughout the season.	A landscape that contains multiple flowering plants and trees throughout growing season, located near water and above floodplain is a good place to keep bees. A landscape that is not treated with pesticides or herbicides is best.
In as much detail as possible, describe what you look for when you inspect your hives.	0	Did not answer the question. Not used in analysis	This is my first year beekeeping. I'm still waiting to order my nucs.
	1	The response lists activities or actions they take when inspecting, but do not provide any context. Context is a description of timing, intent or reasoning, causation for or the impact of the action/activity.	Queen Brood pattern Mites
			check frames, check for parasites, check the queen, check for eggs [*sic*]

	2	The response lists activities or actions that they take when inspecting, and for at least two of the activities/actions listed they provide context. Context is a description of timing, intent or reasoning, causation, or the impact of the action/activity.	I look for the condition of the bees and comb to be sure there are no signs of diseases. Check the cells for eggs, larva and capped brood Check for small hive beetle, varroa mite or other pests Check their food stores Look for any unusual deaths Look at the condition of the bees themselves looking at wings (DWS) ect [*sic*]
	3	The response lists activities or actions that they take when inspecting, and for at least two of the activities/actions listed they provide context and describe any secondary actions or results of their inspection. Context is a description of timing, intent or reasoning, causation, or the impact of the action/activity. The answer does not list any misconceptions or actions/activities that are not beneficial to the hive. Additionally, these answers discuss issues regarding the impact of *Varroa* (if applicable to their location) or availability of forage/nutrition/resources in the hive.	Healthy brood- is the queen laying a good pattern. Population- are there a lot of nurse bees and workers in the hive? Presence of pests- varroa, hive beetles, wax moths. Pollen and honey stores, available space (do I need to add a honey super).
	4	The response lists activities or actions that they take when inspecting, and for all of the actions/activities listed they provide context. Context is a description of timing, intent or reasoning, causation, or the impact of the action/activity. They also describe any secondary actions or results of their inspection. The answer cannot list any misconceptions or actions/activities that are not beneficial to the hive. Additionally, these answers discuss issues regarding the impact of *Varroa* (if applicable to their location), forage/nutrition/resources in the hive, as well as discuss how the time of year plays a role in their inspections.	It depends on the season and environmental factors in our area but in spring/late winter we're looking for good brood patterns and stores as well as swarm cells, in springs looking for good brood pattern and increasing stores/need for added space. In autumn we look for decreasing brood and stores so we can reduce the hive size to a manageable space they can heat and eat from. Nominally look for SHB but rely on a strong hive to keep them at bay. Looking for DWV and other Varroa-related illnesses all year to determine if a hive can stay or needs to be eliminated as we prefer not to treat with chemicals however, with new bees we will treat once or twice to see if they develop hygienic behavior.

Qualitative Results. I also used interviews to examine domains of pollination process, insect conservation, and beekeeping management (See questions 2, 3, 4, and 5 in **Appendix E**). Responses for the program participants in the pre-interview and post-interview were relatively similar. When asking beekeepers to place an apiary on a plot of land, beekeepers were concerned about the closeness of their apiary to crops, the available floral resources on the plot of land, the presence of a windbreak, and closeness to an available water source. Almost every participant added additional resources (e.g. floral resources, trees, water) for their bees. Therefore, knowledge regarding honey bee management did not change over the course of their participation in the program.

A major theme in both the program participant and non-program participant responses was the need for knowledge regarding pollination biology, specifically participants lacked knowledge regarding wild pollinators and held a number of pollination misconceptions. In regard to a lack of knowledge of wild insect pollinators, when asked to pick a pollinator to protect, honey bees were selected 14 times. Participants said they selected honey bees for one of the following reasons: they already own honey bees, honey bees are of value to them (e.g. pollination services or honey), or because honey bees were the only bee they recognized on the list provided to them. Mason bees were picked three times, once under the belief that when mason bees "are gone they're gone," with the attitude that the beekeeper wanted to pick a native bee, or they said mason bees were the only wild bee they knew about on the list. Beekeepers were relatively knowledgeable about honey bees, hence why some beekeepers selected honey bees, but lacked knowledge

regarding other types of bees. However, when asking beekeepers to list pollinators, vertebrate pollinators were listed 11 times and wind pollination was listed five times. Therefore, while beekeepers are aware of wild pollinators and other types of pollinations, program participants still lacked knowledge regarding wild insect pollinators after completing the Women in Beekeeping program.

Furthermore, there were a number of pollination misconceptions within the interviews. Three program participants, Janet, Kristin, and Margaret, all held the misconception that flowers only bloom during the spring. However, Kristin and Margaret only state this misconception in their pre-participation interview. Additionally, when asked to list pollinators, Margaret listed humans as a pollinator in her first interview, even though humans are not pollinators. Some program participants did not mention these same misconceptions in their post-participation interviews, indicating some improvement in terms of dismissing pollination misconceptions. Additionally, all of the non-program participants listed pollination misconceptions, compared to three of the nine program participants listing misconceptions. Georgia also listed humans as pollinators, and Eleanor listed aphids as pollinators. Furthermore, Georgia stated that honey bees do not purposefully collect pollen from flowers. Therefore, while pollination biology knowledge was lacking from all participants, program participants demonstrated a better understanding of pollination biology than non-program participants.

Mixed Methods Findings. The mixed methods question examined if the quantitative data confirmed the qualitative data. When examining how the program participants change over time, the quantitative data and qualitative data converge.

Their total knowledge score, the quantitative strand, marginally increases, after the participants finished the program, but is not statistically significant. Whereas the qualitative themes stay consistent over time. I noticed small changes in the qualitative themes, but these changes were not large enough for me to confidently say that I saw any change over time in the emerging themes. Additionally, there was a marginal increase in knowledge scores over time. Therefore, it is speculated that these small changes in the quantitative and qualitative strands could add up to create a marginal increase in knowledge.

In comparing the program participants to the non-program participants, the quantitative findings and qualitative findings converge on the conclusion that after participating in the program, the program participants performed better in terms of knowledge than the non-program participants. The total knowledge scores for program participants after participating in the program were marginally higher than the non-program participants. When looking at the qualitative themes, the program participants and non-program participants had similar levels of knowledge regarding honey bees, but program participants were higher regarding pollination biology, which was covered by the learning circles, echoing what we found in the quantitative strand, that program participants performed at a slightly improved level.

SQ2: how does the Women in Beekeeping program impact beekeeper self-efficacy?

Quantitative Results. A self-efficacy scale was designed for this survey, based on three of the four pillars of self-efficacy: verbal persuasion, performance attainment, and physiological state. These are questions 31-34 on the survey (See **Appendix C**). The responses to each question were summed to create three self-efficacy scores based on the three pillars of self-efficacy that were examined. To compare the program participant answers prior to and after completing the program, a Signed Rank Test was used to examine the summed question scores for verbal persuasion, physiological state, and performance attainment. Program participant scores for self-efficacy in verbal persuasion increased significantly pre-survey to post-survey (z= -3.2301, p = 0.0313) and marginally increased for performance attainment (z= -3.0301, p = 0.0781). Physiological state was not significantly different prior to and after participation (z= -7, p= 0.3125; see Table 2.7). A Wilcoxon Rank Sum was used to compare the post-participation program participant scores to the non-program participants, and there was no significant difference (Verbal persuasion: z= 265, p= 0.336; Performance attainment; z= 226.5, p= 0.149; Physiological state; z= 306.5, p= 0.679).

Table 2.7

Comparison of program participant summed self-efficacy scores prior to and after completion of the program

Survey Question	Average Score Prior to Participation	Average Score After Participation	Signed Rank *p*-value
Verbal Persuasion	8.5	9.86	0.0313
Physiological State	18.89	20.14	0.3125
Performance Attainment	22	23.86	0.0781

Qualitative Results. Since self-efficacy by definition can only be measured by an individual and not by someone else (Bandura, 1986), I focused on behaviors and interview responses that indicated a change in confidence from the participants. The program participants with more than three years of experience beekeeping did not show indicators of changing self-efficacy. I did see indicators of self-efficacy change with the less experienced beekeepers. There were changes in beekeeper confidence in their inspection behaviors, and then I had beekeepers who directly told me that they were more confident beekeeping.

In terms of inspection behaviors, I saw a theme of improved inspection confidence, and performing more of the inspection. During Janet's first two inspections, she said "I don't know," after many of the questions I asked her. However, I noticed her using less "I don't know" statements during the mid-season inspection. During the last inspections she stopped saying "I don't know" all together. Using less "unsure" statements may indicate that she has become more confident when discussing her beekeeping. Kristin had a similar experience, showing more confidence in her beekeeping decisions and asking me fewer

questions during hive inspections. She began taking notes during her second inspection to help her track her beekeeping management practices. She also altered how she took notes throughout the season. She began the season by not taking notes, then moved to taking written notes, and then ended the season by voice recording her notes on her phone. Both Janet and Kristin also discussed their feelings of increased confidence during their interviews. Janet said, "It [the program] helped me recognize, it helped me a lot doing the inspections to recognize things I can look for and things that I didn't really think about." Additionally, during her last inspection, Janet points out that now she can confidently identify eggs and larva within a colony. In Kristin's pre-program interview, she discussed how she thinks of herself as an "incompetent beekeeper". However, in her post-program interview, she refers to herself as needing to be a more proactive beekeeper instead of an incompetent beekeeper. Margaret did not show any changes in her inspection behaviors but told us during her interview that were it not for this program and the Nebraska Beekeepers Association scholarship (which her daughter received), she would have waited to start keeping bees. The support provided by the program was important for her in feeling comfortable enough to begin beekeeping. While some of the changes in their inspection behaviors may be a result of becoming more comfortable with having someone observe them, part of these changes may be attributed to a change in self-efficacy.

Fiona and Julia also showed changes in their inspecting behaviors, but these behaviors are more dramatic and noticeable than Janet and Kristin's. Fiona did not inspect her hives until her last inspection. During the first inspection, when I asked

her to inspect her hives while I observed, she declined. I inspected the hives for her during the first four inspections, but she conducted the final inspection while I observed. Julia also declined to inspect, letting her husband take charge of the inspections. She even stated at one point that she "just prefers to watch." However, I noticed that Julia began helping more during inspections throughout the season, such as smoking the bees or putting the lid on the hive when needed. She was also able to spot the queen bee and drones in later inspections. She even held a frame of bees at one point. Both Fiona's and Julia's change to active participants in hive inspections by the end of the program may indicate an increase in confidence working the bees.

Mixed Methods Findings. The mixed method question was, "How does the quantitative findings confirm the qualitative findings?" The quantitative findings confirm the qualitative findings. There was a significant increase in program participant verbal persuasion over time and a marginally significant increase in program participant performance attainment over time that was corroborated with the qualitative findings. Janet and Kristin both showed more confidence in their actions and how they spoke about their beekeeping, leading me to believe that their verbal persuasion may have increased. Verbal persuasion is persuading oneself that they can complete a task based on what others have told them (Bandura, 1986). Given how they speak about their beekeeping, saying "I don't know" less and verbally saying that they are more confident, Janet and Kristin may have increased their verbal persuasion. During the inspections, I was able to reassure Janet and

Kristin about their beekeeping skills. Therefore, there may be a connection between the increased verbal persuasion score and how their actions change.

Julia and Fiona both became more involved in their hive inspections as the season progressed. These actions potentially link to the significant increase in performance attainment. As they either became more comfortable being around me during inspections, or became more comfortable performing inspections in general, they were more involved with the inspections. For Fiona this manifested in actually performing the inspection instead of having me perform the inspection. For Julia, this manifested in her helping her husband more throughout the inspection. As they continued to have positive interactions with inspections, they continued to become more comfortable with performing them. This corroborates the quantitative data, that their performance attainment increased over the course of their participation in the program.

SQ3: how does the Women in Beekeeping program impact beekeeper management?

Quantitative Results. The survey asked beekeepers to select problems that they have encountered while beekeeping. Then they were asked to select the most important problem to them and explain why that is a problem. Finally, they were asked how they have addressed this problem (Table 2.8; Table 2.9; Table 2.10). The survey asked beekeeper to choose where they get information regarding bee health from. Data for this information is presented Table 2.11.

Table 2.8

Beekeeping problems listed by program participants prior to participation in the Women in Beekeeping program

Problem	Why this problem?	How have they addressed the problem?
1. *Varroa* (55.56%) (n=5)	1. Struggles to manage (40%) 2. Did not list why (20%) 2. It is killing their bees (20%) 2. It is extremely destructive (20%)	1. Management (80%) 2. Did not answer (20%)
2. Poor management (11.12%) (n=1)	Only problem they have (100%)	Management (100%)
2. Pesticides (11.12%) (n=1)	Struggles to manage (100%)	Management (100%)
2. Viruses (11.12%) (n=1)	Did not list why (100%)	Talk to others (100%)

Note. The term "management" refers to beekeepers taking some action to address an issue or health of their hives.

Table 2.9

Beekeeping problems listed by program participants after their participation in the Women in Beekeeping program

Problem	Why this problem?	How have they addressed the problem?
1. Pesticides (28.57%) (n=2)	1. Struggle to manage (50%) 2. Did not answer (50%)	Management (100%)
1. Queen Issues (28.57%) (n=2)	1. Only problem they have (50%) 2. Did not answer (50%)	1. Management (50%) 2. Talk to others (50%)
2. Poor Management (14.29%) (n=1)	Struggles to manage (100%)	Management (100%)
2. *Varroa* (14.29%) (n=1)	It is extremely destructive (100%)	Management (100%)
2. Weather (14.29%) (n=1)	Did not say why (100%)	Management (100%)

Note. The term "management" refers to beekeepers taking some action to address an issue or health of their hives.

Table 2.10

Beekeeping problems listed by non-program participants, includes 71 non-program participants

Most Important Problems Beekeeping (Top Five)	Why this problem? (Top Five per Problem)	How have they addressed the problem?
1. *Varroa* (64.79%) (n=46)	1. Did not list why (30.43%) 2. Struggles to manage (23.91%) 3. It is extremely destructive (17.39%) 4. The ripple effect (13.04%) 5. It is killing their bees (8.70%)	1. Management (97.83%) 2. Didn't answer (2.17%)
2. Pesticides (11.27%) (n=8)	1. Struggles to manage (75%) 2. The ripple effect (25%)	1. Talk to others (62.50%) 2. Management (25%) 3. Does not know what to do for problem (12.5%)
3. Small Hive Beetle (8.45%) (n=6)	1. Did not list why (66.67%) 2. It is extremely destructive (16.67%) 2. Not educated on the topic (16.67%)	1. Management (83.33%) 2. Did not answer (16.67%)
4. Poor Management (7.04%) (n=5)	1. Struggles to manage (60%) 2. The ripple effect (20%) 2. It is within their control (20%)	1. Education (60%) 2. Management(40%)
5. Lack of Forage (5.63%) (n=4)	1. Struggles to manage (50%) 1. Did not list why (50%)	1. Management (50%) 2. Plant more forage (50%)

Note. The term "management" refers to beekeepers taking some action to address an issue or health of their hives. The term "education" refers to beekeepers who plan on trying to learn more about a topic. This is different than "talk to others" where beekeepers specifically mentioned trying to discuss the topic at hand with another person, versus "education" where beekeepers specifically mentioned trying to learn more about the topic.

Table 2.11

The top five sources of information that beekeepers selected

	Top Five Sources of Information
Program participants pre-participation survey (n=9)	1. Books (9) 2. Other Beekeepers (7) 3. Extension (5) 3. Magazine (5) 4. Web Forums (4) 4. Academic Journals (4) 4. Researchers (4)
Program participants post-participation survey (n=7)	1. Web Forum (7) 1. Other Beekeepers (7) 2. Books (5) 3. Magazines (4) 4. Researchers (3) 4. Academic Journals (3)
Non-program participants (n=89)	1. Other Beekeepers (84) 2. Web Forum (76) 3. Books (71) 4. Researchers (51) 5. Blogs (49)

I asked three survey questions regarding bee management: Is there anything you already are doing to help pollinators; What are other actions (that you are not currently doing) that you could take to help pollinators; and during the growing season (when bees are actively foraging) how often do you inspect your hives (survey questions 15, 16, and 22 respectively, see **Appendix C**). A framework was used to score responses on actions participants are already taking or can take to help pollinators (Table 2.12). A Fisher's Exact test was used to analyze responses. There was no difference in scores for program participants prior to and after participation in the program (Is there anything you already are doing to help pollinators: M_{pre}= 1.89, M_{post}= 2.14, p= 1; What are other actions (that you are not currently doing) that you could take to help pollinators: M_{pre}= 2.11, M_{post}= 2.43, p=

0.1429). Additionally, the responses of: Is there anything you already are doing to help pollinators; and what are other actions (that you are not currently doing) that you could take to help pollinators, were summed to create a "help pollinators" variable. A Signed Rank test was used to examine these scores prior to and after participation for program participants. There was no significant difference between the program participant scores pre and post program participation (M_{pre}= 4, M_{post}= 4.43, z= -3.5, p= 0.375). A Signed Rank test was also used for how often beekeepers inspect their hives. There was no significant difference prior to and after participation for the program participants (M_{pre}= 2.56, M_{post}= 2.43, z= -1, p= 1). I compared the post-participation scores for program participants to the non-program participants for the same survey questions. To examine these scores a Wilcoxon Two-Sample test was used, and there were no significant differences in scores between the program participants (PP) and the non-program participants (NPP) (Help Pollinators: M_{PP}= 4.43, M_{NPP}= 3.69, t= 434.5, p= 0.1543; During the growing season (when bees are actively foraging) how often do you inspect your hives: M_{pre}= 2.42, M_{post}= 2.76, z= 279.5, p= 0.3907).

Table 2.12

Survey response framework

Is there anything you are already doing to help pollinators? / what are other actions (that you are not currently doing) that you could take to help pollinators?	0	Does not answer the question. Not used in the analysis.	*No response was given a 0.*
	1	They list activities without providing context of the answer. Context is a description of the timing, intent or reasoning, causation, or the impact of the activity. Or, the only activity listed was focused on keeping bees,presumably *Apis mellifera*, or any of the activities listed harmed any pollinators.	No pesticide use, traps for hornets, housing bees, no herbicides
			Planted pollinators, keeping bees
	2	At least one activity would help pollinators other than honey bees, and they provide context for at least one activity. Context is a description of the timing, intent or reasoning, causation, or the impact of the activity. All of the activities listed were locally situated actions, meaning that the impact of the action only aided pollinators on the respondent's immediate area (e.g.backyard, acreage, etc.) or the actions were aimed at a specific pollinator.	Plant wide variety, focus on bridging seasons with flowering plants, water source available, feed hummingbirds
			I try to plant pollinator friendly plants, don't use insecticides or pesticides, build "houses" for wild bees
	3	At least one activity would help pollinators other than honey bees, and they provide context for at least one activity. Context is a description of the timing, intent or reasoning, causation, or the impact of the activity. At least one action is a broader-impact action, which is an action that impacts a large pool of pollinators (e.g. research, outreach, education, giving seeds away).	Planted over 200 perennial plants that attract pollinators Leave a lot of open soil on my property to encourage native bees that nest underground. Talk to people about important of habitat loss and bee loss Removed some existing grass from property to zeroscape with pollinator friendly plants Leave small water dishes out with rocks for pollinators to drink from

Qualitative Results. To examine management, I focused on the following interview question: In some instances you, or someone you know, may need to use pesticides (e.g. insecticides, herbicides, fungicides) and what would you do to mitigate the risk of bees being exposed to pesticides, if you need to use them (interview question 7, see **Appendix E**). I also looked at the codes and themes from

the hive inspections. There was no shift in their management behaviors over the course of their involvement in the Women in Beekeeping program. Inexperienced beekeeping actions were more associated with the years of beekeeping and involvement in the larger beekeeping community than with involvement in the Women in Beekeeping program.

When asked about pesticide management, beekeepers listed good management practices. Covering the hive, closing the hive so honey bees cannot get out, and moving the hive to a different location were the most popular ways to mitigate exposure to pesticides. Again, there was not a large shift in responses given between the pre and post program participation interviews. There also was not a large difference between the program participants and the non-program participants. From this data I assume that management did not change due to their involvement in the program.

Mixed Methods Findings. The mixed method question asks, "How do the management scores confirm the qualitative findings?" The quantitative and qualitative findings converged, in that there were no significant changes regarding management for the program participants over time or any differences between the program participants and non-program participants.

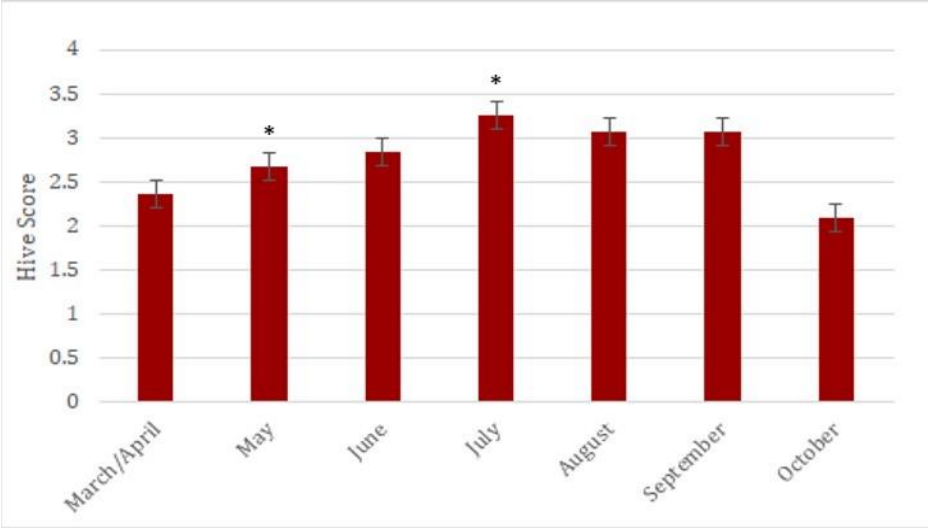
SQ4: how does involvement in the Women in Beekeeping program impact honey bee colonies?

Quantitative Results. A total of 157 hive inspections were conducted from March to October 2019, leading to a total of 157 hive scores from nine program

participants (Figure 2.7). To examine how these scores changed over time per beekeeper, a repeated measures ANOVA was used to test scores from May to July. The scores from these months were used because there was hives score data from 7 of the 9 program participants (Figure 2.8). Julia and Amelia did not have consistent enough collection of hive scores to be used in this test. Homogeneity of variance assumptions were met, with the exception of scores from July. To account for this, hive scores from July were transformed using Log10. Overall, there was a marginal difference when examining the hive scores by month (Wilks' lambda = 0.766, $F(2, 18) = 2.747$, $p = 0.054$, multivariate $\eta^2 = 0.234$). To determine which months were significant, a t-test was used to compare May to June and May to July. Hive scores were not significantly different between May ($M = 2.61$) to June ($M = 2.84$) but did significantly increase in score from May ($M = 2.61$) to July ($M = 3.38$, SD = 0.347, $t = 2.537$, $p = 0.018$).

Figure 2.7

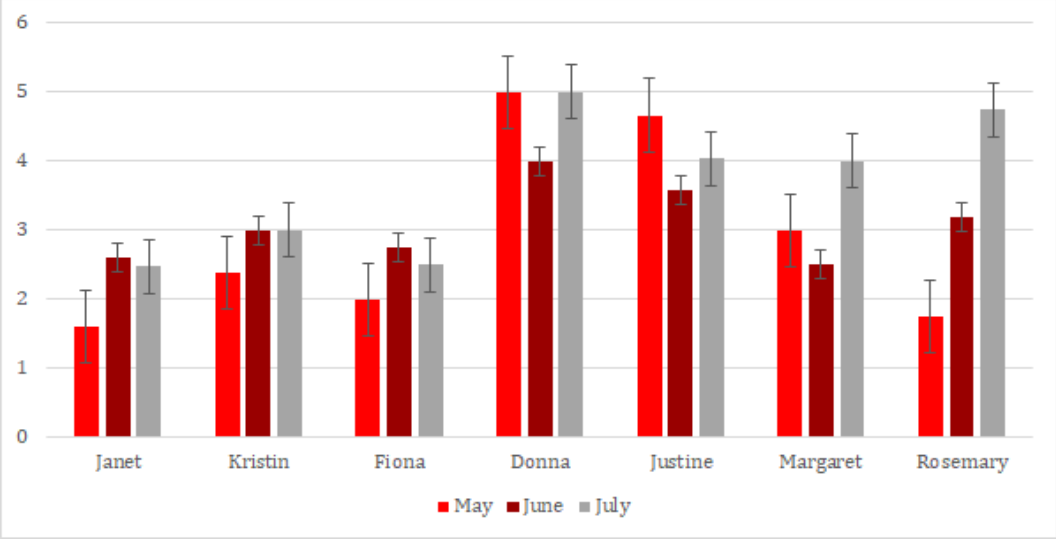
Average hive score per month



Note. This figure includes all nine program participant scores (n = 157 total hive scores from March-October). Error bars represent +/- 1 standard error.

Figure 2.8

Average hive score per beekeeper per month for May, June, and July



Note. Error bars represent +/-1 standard error.

Qualitative Results. In examining colony health, I used the interview questions: How do you tell if an area is good for bees; and can you list factors that impact bee health? The major theme within colony health was what is important to beekeepers during an inspection. Beekeepers focused on the need for water sources near their colonies, the need for windbreaks in their apiaries, the need for an easily accessible apiary, and the need for floral resources available for the bees. Additionally, factors that beekeepers think impact honey bees included *Varroa* mites, the application of sprays (pesticides, herbicides, fungicides) near their colonies, the local weather, and other pests/diseases. The overall factors and needs of colonies were similar between pre- and post-program participation interviews and between program participants and non-program participants. Another common theme was how management impacts colony health. Kristin, Fiona, Donna, and Eleanor all discussed how management is a factor that impacts colony health.

However, while there are common factors and needs that beekeepers list for colony health, some of the individual answers of the program participants did vary between their pre- and post-participation interviews. Fiona, Donna, Justine, and Rosemary gave different answers in their pre- and post-program interviews, but their answers were not necessarily better or worse in terms of beekeeping management between the interviews. Kristin, Julia, and Amelia's answers improved from their pre-participation to post-participation interviews. For Julia, her beginning answer was that she did not know anything about factors that impact honey bees, but in her post-participation interview was able to list three factors.

Kristin and Amelia both make slight changes in their wording, going from broadly saying that forage and food is important for honey bees, to the more specific: forage and floral resources need to be available throughout the season for honey bees. While this change in wording is small, it is an important distinction for beekeepers to make as it indicates that they care about the diversity of resources available to their honey bees, not just access to resources.

Mixed Methods Findings. The mixed methods question examined how the quantitative hive scores confirmed the participant's views of colony health (qualitative strand). While the hive scores increased from May to July, I hypothesize that this increase naturally occurs as hives grow stronger as the weather becomes warmer and more floral resources become available for honey bees. In terms of the qualitative strand, there were slight improvements in the program participant's interview responses over time. These small changes converge to show that program participants improved marginally over time in terms of colony health, however some of these improvements may be a result of natural improvements in hive health over time.

Discussion and Conclusions

Program Evaluation

The final question of the post-program involvement interview asked participants if they found the Women and Beekeeping program useful. Every program participant found the program beneficial, although their reasons why varied. This in of itself

was interesting, as participants did not all have the same level of involvement in the program. The four main themes we found in their responses were:

1. Learning about inspections
2. The systematics of inspecting
3. Accessibility of the program content
4. Community engagement

Janet, Julia, and Margaret discussed how they enjoyed being able to learn about inspections. Most of the participants would ask me questions about how to conduct an inspection, and my preferences for inspecting. For these three, the learning moments were especially important. As Margaret, a first-year beekeeper, stated, "Just knowing that somebody who knew what they were doing was coming out here and confirming that everything was fine." Having the support of the research team and larger beekeeping community was important to her experience.

The systematics of inspecting is used to describe beekeepers who found that the program helped keep them on track in terms of management. I took this terminology from Donna, "I am more systematic I think in evaluating things in the hive...and I feel like we did a much more thorough investigation of them every month, you know, so that I knew what was, what was going on." Donna, Kristin, and Rosemary all mentioned this as a positive of the program. All three noted that having someone come out to observe them (during hive inspections) made them more diligent about conducting inspections and taking notes on their hives in our absence. Kristen stated, "It also impressed the importance of weekly checks so that when you showed up, I didn't just say, 'Oh, I dunno'." Rosemary discussed how

having me visit her hives helped her to create a regular schedule of when she wanted to inspect her hives.

The accessibility of the program's content was largely praised by the participants. Fiona, Julia, and Janet all liked that some of the content was video recorded and put online for them to view. All mentioned that they liked being able to participate in video webinars so they did not have to worry about having to drive - some lived an hour or more away from Lincoln, Nebraska where most learning circles were held. Additionally, Janet and Fiona noted that they enjoyed being able to rewatch the learning circles at a later date. Fiona specifically mentioned that she rewatched the learning circles multiple times so she could better absorb and remember the information. Kristin wanted more of the learning circles either streamed, taped, or held closer to her so she could make them after work. She mentioned that she missed a few of the learning circles due to the driving distance.

The last theme that emerged was community engagement. Justine, Margaret, and Amelia enjoyed being able to engage with the learning circle and beekeeping community. Margaret started beekeeping in 2019 because she felt she had the support of the beekeeping community and research team. Amelia, who had been beekeeping for 8 years, stated that she enjoyed the program for providing a chance for beekeepers and landowners to talk and educate each other. Justine stated, "I just thought it was really interesting [to watch other women beekeepers] and I feel like part of the things that they're doing, I could definitely use."

Pre- and Post-Program Participants

Total knowledge scores and self-efficacy scores marginally increased for program participants after partaking in the Women in Beekeeping program. This was expected, knowledge and self-efficacy are linked together, and as a person becomes more knowledgeable their self-efficacy will likely increase (Holmes, 2016; Schunk, 1984; Stajkovic, 1996). However, management scores did not change over time, and there were few qualitative changes regarding management, knowledge, or self-efficacy.

Kristin started taking notes during her time in the program, a management change that I noted, but her notetaking ultimately did not lead to any changes in hive health or self-efficacy. However, by taking notes, she noticed that she regularly had high levels of *Varroa* in her colonies. In 2020, the year after the research program, Kristin contacted me about how to treat her hives for *Varroa* using chemicals, showing a shift from previously not using chemical treatments. In this case had she not contacted me, I would have been unaware about this change in *Varroa* treatment. Therefore, with more time to observe the beekeepers, I would expect more changes in management, and more qualitative changes in knowledge and self-efficacy, because there would be more time for beekeepers to make these changes.

The four beekeeper's colonies (Donna, Justine, Margaret, and Rosemary) with the highest health scores had a mix of experience (Figure 2.8). Two of these beekeepers had more than four years of experience and performed well at inspecting their colonies (Justine and Rosemary). However, even though Donna and

Margaret performed a number of inexperienced actions, their hives were still relatively healthy. All four beekeepers had their hives on pieces of land that provided ample nectar and pollen resources throughout the beekeeping season. Given that the resources a piece of land provides can influence the health of a colony, I suspect that as long as the honey bees are provided with enough resources, beekeeper behavior may not be very influential on hive health.

Furthermore, all of the program participants were knowledgeable regarding how to design a landscape for honey bees, but not all beekeepers applied this knowledge within their own apiary landscape and provided a decent landscape for honey bees. Part of this is logistical, as beekeepers may not have the capital, authority, or labor to design their apiary landscape for honey bees. This does bring into question how impactful beekeeper knowledge may be on hives if the beekeepers cannot apply the knowledge they have due to extraneous factors. Given that all of these factors, landscape resources, management practices, and beekeeper knowledge, are intertwined, future research needs to examine how much of colony health is dependent on beekeeper management, land resources, and beekeeper knowledge.

Program Participants Versus Non-Program Participants

On average, the program participants were younger, had less beekeeping experience, and owned more land than non-program participants (Table 2.3). *Varroa* was the number one problem given by program participants in the pre-survey and by non-program participants. (Table 2.8; Table 2.10). Pesticides and

queen issues were the number one problem for the post-survey program participants (Table 2.9). There is a wide variation in the program participant responses due to the lower number of respondents (9 pre-survey and 7 post-survey). These problems are typical problems that all U.S. beekeepers face.

Additionally, the program participants used academic journals as a source of information whereas non-program participants did not (Table 2.11). However, the program participants and non-program participant were similar in terms of their management strategies, levels of self-efficacy, and views on colony health. Program participants also performed better than non-program participants on questions regarding knowledge. This is surprising, as we expected the non-program participants to perform better than the program participants due to being older and having more beekeeping experience. Some of the explanation for this difference could be that the Women in Beekeeping program helped program participants reach higher levels of knowledge, similar levels of management strategies, self-efficacy, and views on colony health compared to the non-program participants. A second explanation could be that since program participants referred to academic journals more than non-program participants, program participants are gaining more scientifically-based knowledge on general pollination knowledge and honey bee management.

A third explanation for these differences between program participants and non-program participants may be based in how these groups view honey bees. I asked participants if they thought of honey bees as wild animals, livestock, or pets. How one views their honey bees will impact how they treat their honey bees.

Someone who takes a more utilitarian approach, defined by Kellert (1996), is more likely to focus how their livestock (honey bees in this case) can benefit them. I make the assumption that someone taking a more humanistic approach is more likely to emotionally bond to their honey bees. These thought processes and views then correlate with someone who may think of their honey bees as livestock, a utilitarian paradigm, or as pets, a humanistic paradigm. While half of program participants and non-program participants viewed honey bees as livestock, more program participants thought of bees as wild animals and pets than non-program participants (Table 2.5). Taking a more humanistic approach to honey bees means that those program participants might be more attuned to the needs of their honey bees and the environment around them. Viewing honey bees as pets could explain why the program participants were able to answer questions regarding pollination biology better than the non-program participants - they are more attuned and bonded to the larger environment and therefore more cognizant of general pollination knowledge.

Future research could examine how much of a beekeeper's behavior and management strategies is determined by their knowledge versus their intrinsic beliefs and values. During her interview, Fiona classified honey bees as livestock because that is what she has been told, but personally believes they are wild animals, "I know that they're livestock, but I really think they're wild animals." This fundamental difference in beliefs regarding honey bees could potentially explain some of the differences between the program participants and non-program participants.

Limitations

One major limiting factor of this research is that I only collected data over one beekeeping season. While I did not see any changes in terms of management, one beekeeping season is not enough time to make changes in management strategies and for me to capture these changes with quantitative or qualitative data. For example, Kristin switched how she managed for *Varroa* in 2020 due to the program, something that I would not have captured had she not contacted me. Additionally, with the knowledge data, I noticed small changes in their knowledge that summed to a marginal increase in the program participant's total knowledge score. I speculate that if I followed these participants for a longer amount of time, I would continue to see increases in their knowledge. The beekeepers would continue to apply what they learn from the program within their hives, and I would be able to better capture these changes with quantitative data. Therefore, this research is only the beginning of examining how educational programming impacts beekeepers, as I need more time to truly understand the impacts.

Additionally, I only followed nine beekeepers who participated in the program, which is limiting for the quantitative data. Since the program was informal, there were often different groups of people at the different learning circles, with some of the program participants only attending one learning circle. The level of program involvement was not of particular concern, as the Women in Beekeeping program was intended to be informal and not strict in terms of who was or was not attending. However, it does make it more difficult to determine whether

the changes I see within the program participants is from involvement in the learning circle or from something else.

Furthermore, one of the difficulties of conducting mixed methods research is balancing the different sample sizes needed to conduct rigorous quantitative and qualitative studies. Quantitative studies rely on large sample sizes, typically more than one hundred samples, to obtain the necessary power for statistical analysis. Whereas qualitative studies focus on smaller groups of individuals, often with fewer than ten individuals. I attempted to control for our lack of program participants by using statistical analyses that could appropriately analyze smaller sample sizes.

However, given that I examined a small group of program participants (n=9), many of the conclusions regarding these participants cannot be extrapolated the larger beekeeping community or other programs. Additional studies are needed to confirm the results of this study and apply conclusions to larger beekeeping communities. In addition to the small sample size, the program participants were all white, cis-gendered women, and 91% of non-program participants were white. Therefore, this research can only be used to describe what occurred to people who are also white or cis-gendered. More research will be needed to see how race and other factors may interplay with beekeeping education.

Lastly, I found that the qualitative measures of self-efficacy were underwhelming. I expected to see changes in confidence and self-efficacy with the beekeeper behaviors during hive inspections and in post-participation interview responses. However, there were very few qualitative changes. This is likely because self-efficacy is determined by the individual, not researchers who are observing

from the outside. Additionally, self-efficacy measures sometimes decrease as people have different experiences (Reeve, 2018). Future research would need to come up with better ways to qualitatively assess self-efficacy.

Future Directions

While both program participants and non-program participants were knowledgeable regarding honey bees, both populations were lacking knowledge regarding wild pollinators and general pollination biology. This is not too surprising as program learning circles were mostly focused on honey bees and land resources. However, beekeepers need to understand how their honey bees play a larger role in their surrounding environments and interact with other pollinators. Knowledge of other insect pollinators is helpful when understanding the benefit of land management, pollinator conservation, and the impacts of beekeeping on other animal and plant species. Further, there is emerging literature showing that honey bees can potentially negatively impact wild pollinators through the spread of pathogens or diseases from honey bees to wild pollinators or through competition for floral resources (Mallinger, Gaines-Day & Gratton, 2017). Given that many of the program participants are concerned regarding the environment, it seems pertinent that we educate our beekeepers on wild pollinators. Providing more education on wild pollinators and their interactions with honey bees would help emphasize why beekeepers need to ensure that their honey bees are healthy.

Additionally, a majority of the program participants enjoyed having me present during the hive inspections. This was because I was able to provide hands-

on help and advice on addressing their issues and problems. Furthermore, program participants were able to request that I teach them specific skills during the hive inspections since they knew that I would be consistently visiting them. For example, Janet, Kristin, Fiona, and Margaret all requested that I show them how to perform a powder sugar roll, a test that is used to measure the density of *Varroa* within a hive. They enjoyed being able to ask questions and share with me their learning. Given that I saw slight improvements in knowledge and beekeeping self-efficacy, I would encourage future programs to continue providing experiential and collaborative education programs. This interaction, while not planned, was listed by all participants to be a valuable learning experience.

References

Adams, E.C. (2016). How to become a beekeeper: Learning and skill in managing honeybees. *Cultural Geographies, 25(*1), 31-47. https://doi.org/10.1177/1474474016682345.

Ainsworth, H.L., & Eaton, S.E. (2010). *Formal, non-formal and informal learning in the sciences.* Onate Press.

Aizen, M.A., & Harder, L.D. (2009). The global stock of domesticated honey bees is growing slower than agricultural demand for pollination. *Current Biology, 19(*11), P915-918. https://doi.org/10.1016/j.cub.2009.03.071.

Alaux, C., Ducloz, F., Crauser, D., & Le Conte, Y. (2010). Diet effects on honeybee immunocompetence. *Biology Letters, 6(*4), 562-565. https://doi.org/10.1098/rsbl.2009.0986.

Apis Information Resource Center. (2020, October 25). *Bee research: What scientists and beekeepers want.* Apis Information Resource Center. https://beekeep.info/a-treatise-on-modern-honey-bee-management/bee-research-what-scientists-and-beekeepers-want/.

Bancheva, E., and Ivanova, M. (2015). Informal learning in the workplace. In *Private World(s): Gender and Informal Learning of Adults* (pp. 157-182). Rotterdam: Sense Publishers.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84(*2), 191-215. https://doi.org/10.1037/0033-295X.84.2.191.

Bandura, A. (1986). *Social foundations of thought and action - a social cognitive theory.* Prentice Hall.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.) *Self-efficacy beliefs in adolescents* (pp. 307-337). Information Age Publishing.

Bowen-Walker, P.L., & Gunn, A. (2003). The effect of the ectoparasitic mite, *Varroa destructor* on adult worker honeybee (*Apis mellifera*) emergence weights, water, protein, carbohydrate, and lipid levels. *Entomologia Experimentalis et Appplicata, 101*, 207-217. https://doi.org/10.1046/j.1570-7458.2001.00905.x.

Brasier, K., Barbercheck, M., Kiernan, N.E., Sachs, C., Schwartzberg, A., & Trauger, A. (2009). Extension educators' perceptions of the educational needs of women farmers in Pennsylvania. *Journal of Extension, 47(3),* 3FEA9.

Carlisle, L. (2016). Factors influencing farmer adoption of soil health practices in the United States: a narrative review. *Agroecology and Sustainable Food Systems, 40(*6), 583-613. https://doi.org/10.1080/21683565.2016.1156596.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3nd ed.). SAGE Publications.

Creswell, J.W., & Moerer-Urdahl, T. (2004). Using transcendental phenomenology to explore the "ripple effect" in a leadership mentoring program. *International Journal of Qualitative Methods, 3(*2), 19-35. https://doi.org/10.1177/160940690400300202.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing*

among five approaches. SAGE Publications.
Dicks, L.V., Showler, D.A., & Sutherland W.J. (2010). Bee conversation: evidence for interventions. *European Journal of Entomology, 108(*2), 196-196. https://doi.org/10.14411/eje.2011.026.
Druschke, C.G., & Seltzer, C.E. (2012). Failures of engagement: lessons learned from a citizen science pilot study. *Applied Environmental Education and Communication, 11*, 178-188. https://doi.org/10.1080 /1533015X.2012.777224.
Eddles-Hirsch, K. (2015). Phenomenology and educational research. *International Journal of Advanced Research, 3(*8), 251-260.
Espinosa, S., & Jacobson, S.K. (2012). Human-wildlife conflict and environmental education: evaluating a community program to protect the andean bear in Ecuador. *The Journal of Environmental Education, 43(*1), 55-65. https://doi.org/10.1080/ 00958964.2011.579642.
Findlay, J.R., Eborn, B., & Jones, W. (2015). Effects of colony creation method and beekeeper education on honeybee (*Apis mellifera*) mortality. *Journal of Extension, 53(*1), 1RIB6.
Gallai, N., Salles, J.M., Settele, J., & Vassaiere, B. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics, 68(*3), 810-821. https://doi.org/10.1016 /j.ecolecon.2008.06.014.
Garback, K., & Morgan, G.P. (2017). Grower networks support adoption of innovations in pollination management: the roles of social learning, technical learning, and personal experience. *Journal of Environmental Management, 204(*1), 39-49.
Golick, D., Dauer, J., Lynch, L., & Ingram, E. (2017). A framework for pollination systems thinking and conservation. *Environmental Education Research, 24(*8), 1143-1158. https://doi.org/10.1080/13504622.2017.1349878.
Grandi-Hoffman, G., Chen, Y., Rivera, R., Carroll, M., Chambers, M., Hidalgo, G., & Watkins de Jong, E. (2016). Honey bee colonies provided with natural forage have lower pathogen loads and higher overwinter survival than those fed protein supplements. *Apidologie, 47,* 186-196. https://doi.org/10.1007 /s13592-015-0386-6.
Grünewald, B. (2010). Is pollination at risk? Current threats to and conservation of bees. *GAIA, 19(*1), 61–67. https://doi.org/10.14512/gaia.19.1.13.
Grüter, C., Moore, H., Firmin, N., Helanterä, H., & Ratnieks, F.L. (2011). Flower constancy in honey bee workers (Apis mellifera) depends on ecologically realistic rewards. *Journal of Experimental Biology, 214*, 1397-1402. http://dx.doi.org/10.1242 /jeb.050583.
Herbert, E.W. (1993). Honey Bee Nutrition. In J.M Graham (Eds.), *The Hive and the Honey Bee.* Dadant & Sons.
Hmelo-Silver, C., & Azevedo, R. (2006). Understanding the complex systems: some core challenges. *Journal of Learning Sciences, 15(*1), 53-61. https://doi.org/10.1207/ s15327809jls1501_7.
Holmes, M. (2016). Sources of self-efficacy information for writing: a qualitative inquiry. [Master's Thesis, University of Nebraska-Lincoln]. Digital Commons.

Huang, Z. (2010). Honey bee nutrition. *American Bee Journal, 150(*8), 773-776.
James, S. (2002). Bridging the gap between private landowners and conservationists. *Conservation Biology, 16(*1), 269-271. https://doi.org/10.1046/ j.1523-1739.2002.01039.x.
Jewitt, C. (2012). An introduction to using video for research. *National Center for Research Methods Working Paper.* http://eprints.ncrm.ac.uk/2259/4/ NCRM_workingpaper_0312.pdf.
Kang, Y., Blanco, K., Davis, T., Wang, Y., & DeGrandi-Hoffman, G. (2016). Disease dynamics of honeybees with *Varroa destructor* as parasite and virus vector. *Mathematical Biosciences, 275*, 71-92. https://doi.org/10.1016/ j.mbs.2016.02.012.
Keane, B. (2016). The learning circle in culture change: why use it? *Pioneer Network.* https://www.pioneernetwork.net/wp-content/uploads/2016/10/The-Learning-Circle-in-Culture-Change.pdf.
Keller, I., Fluri, P., & Imdorf, A. (2005). Pollen nutrition and colony development in honey bees: Part 1. *Bee World, 86(*1), 3-10. https://doi.org/10.1080 /0005772X .2005.11099641.
Kellert, S. R. (1996). *The value of life: biological diversity and human society.* Island Press/Shearwater Books.
Klassen, R. (2002). Writing in early adolescence: a review of the role of self-efficacy beliefs. *Education Psychology Review, 14(*2), 173-203. https://doi.org/10.1023/A:1014626805572.
Lave, J. (1991). *Situating learning in communities of practice.* In L.B. Resnick, J.M. Levine, & S.D. Teasley (Eds.), Perspectives on socially shared cognition (pp. 63-82). American Psychological Association.
Litchman, M. (2013). *Qualitative research in education* (3rd ed.). SAGE Publications.
Lee, H., Sumner, D.A., & Champetier, A. (2019). Pollination markets and the coupled futures of almonds and honey bees: Simulating impacts of shifts in demands and costs. *American Journal of Agricultural Economics, 101(*1), 230-249. https://doi.org/10.1093/ajae/aay063.
Love, B., & Spaner, D. (2008). Agrobiodiversity: its value, measurement, and conservation in the context of sustainable agriculture. *Journal of Sustainable Agriculture, 31(*2), 53-82. https://doi.org/10.1300/J064v31n02_05.
Lugnot, M., & Martin, G. (2013). Biodiversity provides ecosystem services: scientific results versus stakeholders' knowledge. *Regional Environmental Change, 13*, 1145-1155. https://doi.org/10.1007/s10113-013-0426-6.
Lukas, K.E., & Ross, S.R. (2005). Zoo visitor knowledge and attitudes towards gorillas and chimpanzees. *Journal of Environmental Education*, *36(*4), 33-48.
Lynch, L. (2016). Science experiences of citizen scientists in entomology research. [Doctoral Dissertation, University of Nebraska-Lincoln]. Digital Commons
Maderson, S., & Wynne-Jones, S. (2016). Beekeepers' knowledges and participation in pollinator conservation. *Journal of Rural Studies, 45*, 88-98. https://doi.org/10.1016/j.jrurstud.2016.02.015.
Maguire, C.J. (2000). From agriculture to rural development: critical choices for agriculture education. *Sustainable Development Department, Food and Agriculture Organization of the United Nations.*

Mallinger, R.E., Gaines-Day, H.R., & Gratton, C. (2017). Do managed bees have negative effects on wild bees?: A systematic review of the literature. *PLoS ONE, 12(*12), e0189268. https://doi.org/10.1371/journal.pone.0189268.

Mao, W., Schuler, M.A., & Berenbaum, M.R. (2013). Honey constituents up-regulate detoxification and immunity genes in the western honey bee *Apis mellifera. PNAS, 110(*22), 8842-8846. https://doi.org/10.1073/pnas.1303884110.

Meredith, A.M. (2008). Conserving pollinators: an interdisciplinary approach to evaluating the ecological, economic and cultural value of native bees in mid-Atlantic sustainable agriculture. [Doctoral Dissertation, University of Maryland]. ProQuest Dissertations and Theses.

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being.* Island Press.

Moustakas, C. (1994). *Phenomenological Research Methods.* SAGE Publications.

National Resource Council. (2007). *Status of Pollinators in North America.* National Academies Press.

Onwuegbuzie, A.J., & Johnson, R.B. (2006). The validity issues in mixed research. *Research in the Schools, 13(*1), 48-63.

Onwuegbuzie, A.J., Johnson, R.B., & Collins, K.M.T. (2011). *Assessing legitimation in mixed research: a new framework. Quality and Quantity, 45*, 1253-1271. https://doi.org/10.1007/s11135-009-9289-9.

Padilla-Diaz, M. (2015). Phenomenology in educational qualitative research: Philosophy as science or philosophical science? *International Journal of Educational Excellence, 1(*2), 101-110.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66(*4), 543-578. https://doi.org/10.3102/00346543066004543.

Parr, D.M., Trexler, C.J., Khanna, N.R, & Battisti, B.T. (2007). Designing sustainable agriculture education: Academics' suggestions for an undergraduate curriculum at a land grant university. *Agriculture and Human Values, 24*, 523–533. https://doi.org/ 10.1007/s10460-007-9084-y.

Plano Clark, V.L., & Ivankova, N.V. (2016). *Mixed methods research: A guide to the field.* SAGE Publications.

Rimi, T.A.M., & Chudi, A.F.D. (2017). Analysis of the role of information and communications technologies in rural women farmers' empowerment in Rivers State, Nigeria. *Library Philosophy and Practice,* 1498.

Reeve, J. 2018. *Understanding motivation and emotion* (7 eds.). John Wiley & Sons Inc.

Saldaña, J. (2013). *The coding manual for qualitative researchers.* SAGE Publications.

Schunk, D.H. (1984). Self-Efficacy Perspective on Achievement Behavior. *Educational Psychology, 19*, 48-58. https://doi.org/10.1080 /00461528409529281.

Schneider-Cline, W. (2015). The impact of a clinical writing workshop on graduate student performance, self-efficacy, and beliefs about clinical writing. (Publication No. AAI3738574) [Doctoral Dissertation, University of Nebraska-Lincoln]. Digital Commons.

Seeley, T.D. (1994). Honey bee foragers as sensory units of their colonies.

Behavioral Ecology and Sociobiology, 34, 51-62. https://doi.org/10.1007/BF00175458.

Sharafizad, J. (2018). Informal learning of women small business owners. *Education + Training*, *60(*1), 82-103. https://doi.org/10.1108/ET-01-2017-0006.

Shepherd, M., Buchmann, S., Vaughan, M., & Black, S. (2003). *Pollinator Conservation Handbook*. The Xerces Society.

Shortall, S. (1996). Training to be farmers or wives? Agricultural training for women in Northern Ireland. *Sociologia Ruralis, 36(*3). 269-285. https://doi.org/10.1111/j.1467-9523.1996.tb00022.x.

Smart, M., Pettis, J., Rice, N., Browning, Z., & Spivak, M. (2016). Linking measures of colony and individual honey bee health to survival among apiaries exposed to varying agricultural land use. *Plos ONE, 11(*3), e0152685. https://doi.org/10.1371/ journal.pone.0152685.

Sperandio, G., Simonetto, A., Carnesecchi, E., Costa, C., Hatjina, F., Tosi, S., & Gilioli, G. (2019). Beekeeping and honey bee colony health: A review and conceptualization of beekeeping management practices implemented in Europe. *Science of the Total Environment, 696(*15), 133795. https://doi.org/10.1016/j.scitotenv.2019.133795.

Sponarski, C., Vaske, J., Bath, A., & Loeffler, T. (2016). Changing attitudes and emotions toward coyotes with experiential education. *The Journal of Environmental Education, 0(*0), 1-11. https://doi.org/10.1080/00958964.2016.1158142.

Stajkovic, A.D. (1996). Self-efficacy and task performance: a meta-analysis. [Doctoral Dissertation, University of Nebraska-Lincoln.] Digital Commons.

Steyaert, P., Barzman, M., Billaud, J.P., Brives, H., Hubert, B., Ollivier, G., & Roche, B. (2007). The role of knowledge and research in facilitating social learning among stakeholders in natural resources management in the French Atlantic coastal wetlands. *Environmental Science and Policy, 10*, 537-550. https://doi.org/10.1016/j.envsci.2007.01.012.

Šūmane, S., Kunda, I., Nickel, K., Strauss, A., Tisenkopfs, T., Rios, I., Rivera, M., Chebach, T., & Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *Journal of Rural Studies, 59*, 232-241. https://doi.org/10.1016/ j.jrurstud.2017.01.020.

Trauger, A., Sachs, C.E, Barbercheck, M.E., Kiernan, N.E., Brasier, K.J., & Findeis, J. (2008). Agricultural education: gender identity and knowledge exchange. *Journal of Rural Studies, 24*, 432-439. https://doi.org/10.1016/j.jrurstud.2008.03.007.

U.S. Forest Service. (2020, November 1). *Why is pollination important?* Forest Service. https://www.fs.fed.us/wildflowers/pollinators/importance.shtml

United States Bureau of Labor Statistics. (2018). *Standard Occupational Classification Manual.* https://www.bls.gov/soc/2018/soc_2018_manual.pdf.

UNL Bee Lab. (2018). *Hive Inspection Data Sheet.* University of Nebraska-Lincoln. https://unl.app.box.com/s/zulszs870hx7i9nonl8i6604fnxm0764.

vanEngelsdorp, D., & Meixner, M. (2010). A historical review of managed honey bee

populations in Europe and the United States and the factors that may affect them. *Journal of Invertebrate Pathology, 103*, 80-95. https://doi.org/10.1016/j.jip.2009.06.011.

Van Manen, M. (1990). *Researching Lived Experience: Human Science for Action Sensitive Pedagogy.* The State University of New York Press.

VERBI Software. (2019). MAXQDA 2020 [computer software]. Berlin, Germany: VERBI Software. Available from maxqda.com.

Wilensky, U. & Resnick, M. (1999). Thinking in levels: a dynamic systems approach to making sense of the world. *Journal of Science Education and Technology, 8(*1), 3-19. https://doi.org/10.1023/A:1009421303064.

Winston, M. 1993. The Honey Bee Colony: Life History. In J.M. Graham (Eds.), *The Hive and the Honey Bee.* Dadant & Sons.

Westerhold, C. (2017). Horticulture for Pollinator Conservation. [Master's Thesis, University of Nebraska-Lincoln.] Digital Commons.

Wuepper, D., Zilberman, D., & Sauer, J. (2019). Non-cognitive skills and climate change adaptation: Empirical evidence from Ghana's pineapple farmers. *Climate and Development, 12(*2), 151-162. https://doi.org/10.1080/17565529.2019.1607240.

Yang, X., & Cox-Foster, D.L. (2005). Impact of an ectoparasite on the immunity and pathology of an invertebrate: Evidence for host immunosuppression and viral amplification. *PNAS, 102(*21), 7470-7475. https://doi.org/10.1073/pnas.0501860102.

Chapter 3: Experiences of Women Beekeepers

"Maybe we think more about how it impacts our children or future when we, when we look at how bees are in a decline and how it, the use of these chemicals or whatever, it's gonna affect us in the long run. I don't, maybe that's everybody, but it's one of those things, I feel like as a mother, I want to care for my kids too. And I know that beekeeping has opened my eyes to conventional farming, pesticides and herbicides and all the sides." - Rosemary

Literature Review

Women in Beekeeping

While there is a lack of demographic information available on beekeepers, a majority of beekeepers are thought to be male (Ogaba, 2001). However, the numbers of new women beekeepers are growing (Aubrey, 2010). Women beekeepers face many of the same issues as others do in men-dominated fields. Some women beekeepers face sexism from peers and colleagues. As in other professions, women are questioned as to how they plan to balance beekeeping with motherhood (Horn, 2012) and if they can handle the heavy lifting required in beekeeping (A.I. Root Company, 1906; Rogers, 2016). Also, women beekeepers struggle finding suits that fit properly as these suits are often designed for men. Sexism is still found within the beekeeping community to this day.

Colopy (2015) interviewed twelve women beekeepers in the United States who held positions in beekeeping associations. Some were welcomed with open arms and valued by their peers, and others report being unable to hold positions in their beekeeping association due to their gender. The first woman president of the New York Beekeepers' Association, Roberta Glatz, claims that during her tenure the men were always "trying to throw her out" (Horn, 2012). This sexism and discrimination harkens back to the 1800's women where women were not allowed

to attend beekeeper association meetings in the United States even though many women participated in beekeeping enterprises (Horn, 2010; Horn, 2012). Rogers (2016) describes commercial women beekeepers being treated disrespectfully by men peers, including the beliefs held by men colleagues that women are unable lift hive boxes and should stay home to raise the children instead of beekeeping. In other studies, women beekeepers have said they feel the need to prove themselves to their beekeeping employers and co-workers (Colopy, 2015; Horn, 2012; Rogers, 2016).

However, not all women beekeepers report negative experiences. The "father of beekeeping," Lorenzo Langstroth, emphasized the importance of women having access to beekeeping and encouraged husbands to involve their wives in beekeeping (Horn, 2012). During and post-Civil War many women took over their husband's or father's beekeeping businesses, which created a space for women to participate in beekeeping (Horn, 2012). Old beekeeping journals contain articles written by women and encouraged women to keep bees as a way to supplement household income (A.I. Root Company, 1906; Horn 2010; Horn, 2012). In more modern history, a majority of women bee researchers note feeling respected by their men peers (Horn, 2012). It has even been suggested that women may be better beekeepers because they are more gentle and delicate in handling bees (Burlew, 2018; Horn, 2012). There is a wide array of experiences documented by women beekeepers. This makes it difficult to draw conclusions about the current status of women's experiences in beekeeping. As learning is specific to one's situation and culture (Lave, 1991), there is a need to better understand the experiences of women

beekeepers to improve their professional environment. Also, learning more about the experiences of women beekeepers may inform the creation of women-centric educational opportunities.

Women beekeepers are of importance because they likely face different challenges than men beekeepers and make up a growing number of new beekeepers (Aubrey, 2010). Furthermore, honey bees are an agricultural commodity. Their survival is dependent on the care provided by the beekeeper (Sperandio et al., 2019). As a result, educators need to understand the challenges and struggles that women beekeepers face and if these are linked to their gender identity, physical capabilities, or learning needs.

Women in Agriculture. As the literature describing the experiences of women beekeepers is limited, I examined other areas of agriculture to provide insight on women's professional experiences. Agriculture is often considered a "man's field," as approximately half of the world's farmers are women (World Bank, 2017). In Nebraska, 28% of farms are led by women (United States Department of Agriculture, 2017). While nearly a third of farmers are women, they often report feeling isolated, disrespected (Sachs et al., 2016; Trauger, 2004), and not taken as seriously as men, by men, in educational programs (Brasier et al., 2009). These barriers can make it difficult for women to be successful in their farming endeavors. Other barriers reported by women include a lack of childcare and unsupportive parents or spouses. Frequently there is no familial support available for those managing farms, due to a lack of good childcare in rural communities (Brasier et al., 2009) and many husbands are not supportive of their wives farming endeavors

(Jarosz, 2011). In many cases women have to choose between caring for their family or leading their farm.

Another common complaint of women is men's unwillingness to teach them. For example, if a piece of equipment breaks, men often fix it themselves rather than showing their spouse or daughters how to fix it (Trauger et al., 2008). Even though men may be doing this under the guise of helping the women by not bothering them with the problem, this becomes a barrier as women are not learning farm skills. Further contributing to the lack of informal education, fathers often pass down their farming knowledge to their sons and not to their daughters (Sachs et al., 2016).

The agriculture community recognizes that these barriers exist, and some support systems have been created to help women overcome barriers. Programs like Women's Agriculture Network (WAgN) provide grants, workshops, and networking opportunities for women. The Minority and Women Farmers and Ranchers is a program under the Farm Service Agency that provides loans to women and other minorities in agriculture. Similarly, there is a need to help women overcome the barriers they experience in beekeeping, including educational experiences that are tailored for women that include an environment where women are comfortable learning.

Differences in learning needs between genders can contribute to women feeling ignored by agricultural learning spaces. Women usually prefer experiential or discussion-based learning, and men prefer learning in a lecture-based format (Bancheva & Ivanova, 2015; Brasier et al., 2009). Agricultural conventions or workshops tend to be lecture-based, which may isolate women as they report

wanting more experiential learning opportunities, such as group discussions or learning circles (Brasier et al., 2009). While learning from other people is viewed as important by both men and women, women tend to prioritize the ability to openly discuss and learn from their mistakes in informal learning environments, whereas men prioritize gaining respect from others in the same environments (Bancheva & Ivanova, 2015). Women may prefer gender segregated events, as they are more likely to interact and ask questions if there are other women in the room (Sachs et al., 2016). Extension professionals and academics have reported that in presentations men tend to ask their questions during the Q&A portion of the presentation, but women will often wait until after the event is over to ask their questions (Sachs et al., 2016). It is speculated that they tend to ask questions in private to avoid looking "stupid" in front of their male colleagues (Sachs et al., 2016). Women also report feeling more empowered and confident in their education when learning from others in a group instead of a lecture (Macoloo et al., 2013; Mburu et al., 2015; Shortall, 1996). On the other hand, men perceive women farmers to be more knowledgeable when having seen them at educational events or knowing that women have attended such events (Shortall, 1996). Therefore, education is not only important for building the women's knowledge in agricultural practices, but also in helping women to gain the acceptance of their men colleagues. Therefore, it is important to account for women's preferences in learning environments and provide a space that allows them to have an equal footing with men. Women may benefit from gender tailored spaces that can provide them with educational opportunities where they can be most comfortable and successful.

In this study, I am interested in learning more about women's experiences as beekeepers. These experiences are needed to address barriers to beekeeping and ensure that women acquire the knowledge and skills necessary for healthy honey bee management. To address the educational barriers of women in beekeeping, the Center for Rural Affairs (CFRA) and the University of Nebraska-Lincoln Department of Entomology developed the Women in Beekeeping program. This program was designed to provide women with more informal, peer-to-peer discussion-based learning opportunities on honey bee management. As part of this program, women had access to free webinars, field trips, learning circles, and hive inspections. Before and after involvement in this program, I documented program participants' experiences. This chapter explores the experiences of women beekeepers; (RQ2): What are the experiences of women beekeepers in the United States? To answer this question, I ask two sub questions (SQ): (SQ1) are there any specific experiences unique to being a woman beekeeper and (SQ2) what is important to women beekeepers?

Methods

I used semi-structured interviews to answer these sub-questions. The goal of these interviews was to gain insight into how women beekeepers identify, how these identities influenced their beekeeping, their general beekeeping experiences, and how these experiences influence their beekeeping. A total of twelve beekeepers were interviewed, the nine program participants that I followed to answer research question one of this thesis (See Chapter 2, *The Beekeepers*), and the three non-

program participants that were also interviewed (See Chapter 2, *Interviews*). They were all asked questions regarding their identity and experiences as a woman beekeeper during their interviews (See **Appendix E**). The goal of involving non-program participants was to include more experiences of women beekeeper's than just those within the Women in Beekeeping program. Interviews lasted from 30 to 60 minutes, with an average time of 44.21 minutes. Prior to completing the interviews, participants signed an informed consent form (see **Appendix H**).

Program participants were given the option to complete a third, follow-up phone interview. These interviews were completed in January and February of 2020 after the Women in Beekeeping program was completed and lasted 20 minutes. A voice recorder was used to record the conversation for later playback and transcription. This interview covered topics such as their personal identifiers, the role of identity in their beekeeping, and potential long-term impact of the program on participants (see **Appendix F**). Three program participants took part in the follow-up interview: Janet, Fiona, and Rosemary.

Once transcribed, interviews were then coded in accordance with Moustakas' description of transcendental phenomenology. Data analysis occurred in three stages, phenomenological reduction, imaginative variation, and synthesis of meanings and essences (Moustakas, 1994). Phenomenological reduction began by bracketing ones preconceived notions and biases, which was then followed by horizontalization, where every coded statement was treated as having equal value. The statements that are irrelevant or repetitive were then removed to create

"horizons." The horizons were then clustered into themes which were then organized into a coherent description of the phenomenon (Moustakas, 1994).

Imaginative variation is the process by which I look for meaning in the description. I look for potential contextual meaning in the descriptors, underlying themes that account for the emergence of the phenomenon, and examples of the themes (Moustakas, 1994). From there, I attempted to synthesize the meanings and essences of the descriptors. In the context of this research, I asked myself what are the indispensable qualities of the experiences of the women beekeepers, what are the contexts of their experiences, and why does it matter?

Similar to the previous coding methods, I began the process of coding by attempting to bracket my biases. I have been a bee researcher for five years, meaning that I have my own experiences and preconceived notions regarding beekeeping and being a woman in the field of beekeeping. Therefore, prior to coding the data I made note of these preconceived notions, acknowledging that my experiences in beekeeping are not universal. Then, immediately before coding the data, I partook in a reflective meditation, reflecting on my prior beekeeping experiences and actions, similar to the process described by Creswell and Moerer-Urdahl (2004). I used values coding and in-vivo coding to capture the essence of the participant's values, attitudes, and beliefs. Values coding is typically used in studies that explore cultural values, identity and personal experiences, by coding segments as either an attitude, value, or belief (Saldaña, 2013). These are loosely defined:

- Values: the importance we attribute to something or the greater personal meaning.

- Attitudes: the way we think and feel about ourselves, another person, thing, or idea; essentially someone's opinion.
- Beliefs: our personal, embedded values; a value or attitude plus our personal knowledge, experiences, opinions, prejudices, morals, and other interpretive perceptions of the social world (Saldaña, 2013).

These three definitions are not mutually exclusive, as some individual codes encompassed both a value and belief, or attitude and value. I also used in-vivo coding in addition to values coding. In-vivo coding involves using the participants language for codes. I did this as a way to ensure that I am capturing the participant's feelings and essence, as well as a way to avoid imparting my own biases onto the codes. All interviews were coded using the methods described here.

Codes were then entered into a spreadsheet to examine those that were repetitive or unimportant to the research questions. From this sheet, I was able to generate different themes that emerged from the data and answer the research question. To ensure the validity and rigor of this research, I employed two different validation methods (Creswell & Poth, 2018): member checking and bracketing. First, participants were asked to clarify their statements and ensure that I was correctly capturing the participants descriptions during and after the interviews. Second, bracketing, a process whereby the researcher acknowledges their own previous experiences and preconceived notions in an attempt to prevent biasing of the data, occurred as described above (Litchman, 2013).

Rationale for Qualitative Research

Women farmers face a number of struggles that men farmers do not face, and it is assumed that women beekeepers face similar struggles to women farmers. However, while it can be argued that beekeeping is an agricultural endeavor, it is not the exact same as farming. Many beekeepers keep hives in the city, suburbs, and on country acreages. Therefore, I do not assume that the challenges faced by women beekeepers will be the exact same as women crop farmers. The goal of this study is to understand the very situated experiences of small-scale women beekeepers in the Midwest United States. By using a qualitative approach, I can more richly explore the experiences of women beekeepers than if I solely used quantitative data. Furthermore, I do not want to bias my interpretation of the data. By using a qualitative approach and allowing the struggles and benefits of being a women beekeeper to reveal itself to me, I prevent biasing any data. If I instead used a quantitative approach, I would need to make a number of assumptions a priori regarding the participants to design a survey or similar data collection tool. In making assumptions for a quantitative tool without understanding the experiences of these women, I would bias the data by forcing the women to describe their experiences using predetermined terms. Rather, by using a semi-structured interview, I allow the themes to reveal themselves to me through the interviewees' responses.

Phenomenology

This research utilizes a constructivist epistemology. Constructivism, sometimes called interpretivism, argues that individuals construct their own reality, therefore there are multiple realities (Plano Clark & Ivankova, 2016). People's realities are shaped by their preconceived notions and social constructs (Neumann, 2011). When using a constructivist approach, researchers ask themselves what people believe and what they hold relevant to themselves (Neumann, 2011). Each individual constructs their own reality while beekeeping, one person may perceive their bees as angry whereas another may perceive them as calm. Therefore, I must account for the fact that each individual is going to possess their own constructed reality regarding their bees. Phenomenology as a qualitative method focuses on describing the lived experiences of the participant (Creswell & Poth, 2018; Litchman, 2013). Under this definition of phenomenology, I am essentially assuming a constructivist approach, as the goal is to describe what the participants assume to be their reality. Given that this research focuses on better understanding the realities of being a women beekeeper, and the realities the participants believe to be true, a constructivist paradigm is employed.

Phenomenology is a qualitative approach that focuses on describing the lived experiences of participants (Creswell & Poth, 2018; Litchman, 2013; Moustakas, 1994). One does not simply describe a phenomenon within a phenomenology. There is typically the application of a sub approach, philosophy and specific phenomenological analysis that is used (Creswell & Poth, 2018; Litchman, 2013). There are multiple approaches to phenomenology: interpretive phenomenological

analysis (IPA), hermeneutical, transcendental, and other lesser known approaches (Creswell & Poth, 2018; Smith, Flowers, & Larkin, 2009). Transcendental phenomenology focuses on the description of the experiences of the participants, as well as bracketing, or epoch, of researcher biases and opinions (Moustakas, 1994). I expected a broad range of experiences, which would make it difficult to interpret participant experiences. Due to the broad range of expected experiences prior to collecting data, this project aims to describe the experiences of women beekeepers instead of interpreting these experiences, hence the selection of a transcendental approach. However, these described experiences will be used to determine how to better create extension programs regarding women beekeepers.

A key method in transcendental phenomenology is the use of bracketing. Bracketing is where the researcher acknowledges their own biases and attempts to set those biases aside in analysis of the data (Moustakas, 1994). Some may argue that bracketing cannot happen, as how does anyone truly set aside their own biases (Van Manen, 1990). In research it is important to acknowledge and attempt to set aside and reflect on these biases. The experiences of the research team were not included in the analyses, as I attempted to set aside these preconceived notions in analyzing and describing the experiences of the participants. Since this research examines the lived experiences of women beekeepers, it is important for me to set aside my biases and bracket my experiences as a woman beekeeper. Hence why the research team decided upon taking a transcendental, phenomenological approach.

IRB Considerations

Approval for this research was obtained from the University of Nebraska-Lincoln's Institutional Review Board (Approval number:20180818534). In compliance with UNL's IRB I, Bridget Gross, have completed the CITI Training Program. This study utilized women beekeepers ages 19 and older. At no time were participants pressured into engaging in the research. A copy of the Informed Consent Form is located in **Appendix H**.

Results

In this chapter I explored research question 2 (RQ2): What are the experiences of women beekeepers in the Midwest United States? To answer this question, I asked two sub questions (SQ): (SQ1) are there any specific experiences unique to being a woman beekeeper and (SQ2) what is important to women beekeepers?

SQ 1: Are there any specific experiences unique to being a woman beekeeper?

The common experiences described by women included feelings of acceptance, thinking that women are more patient beekeepers than men, and the relation between beekeeping and the family. Two beekeepers reported feeling disrespected or not being taken seriously by men beekeepers when asking or answering questions, "Thinking, if I call for bee [help]...there's, you know, it's always the man and if you, I think they think you're not serious, you know, they don't, I don't think they take you seriously" (Janet). And, "There is something to say about mansplaining of, I can say something on the NBA [Nebraska Beekeepers Association] page and it's

one thing, but [husband] can come back and say the same exact thing and then it's taken as true value" (Amelia). These two denote feelings of not being accepted by men in the beekeeping community.

Conversely, a total of nine beekeepers said that the gender ratio of a beekeeping group did not matter. Six of these beekeepers said that the gender ratio of beekeeping communities did not matter to them because they did not have issues regarding acceptance and the ability to learn from beekeeping groups. Margaret summed up the sentiment of these four beekeepers:

> I think I'd feel a lot more uncomfortable if the numbers [of men versus women beekeepers] were skewed way more or if the attitudes were a little bit off putting, but that has not been our experience. I think just openness, the openness and the willingness to explain to a novice, you know, not feel like we're being annoying or it's taking up their time.

Even though these positive and negative experiences contrast one another - some of the respondents cared about gender ratio and some did not - all of these experiences describe how accepted the women feel by other beekeepers.

A second sentiment shared by three beekeepers is that women are more patient and careful beekeepers than men. Julia thinks that after participating in the Women in Beekeeping program that her husband moves more slowly beekeeping. Eleanor mentions that she thinks she is more patient compared to her husband when beekeeping. Similarly, Rosemary describes her observations in the differences between the men and women in beekeeping classes:

> I know I've noticed that in my classes that the guys can kind of hurry and then we'll [the women] sit there and chat and, you know, move pretty slow around the hive. And apologize, women apologize, we say sorry to bees, 'I didn't mean to squish you.'

These comments form a theme that there may be differences in how women view their beekeeping different from men.

The last group sentiment was described by five beekeepers, describing how their beekeeping is connected to their motherhood. They noted feeling more careful in their beekeeping, echoing the sentiment of being a more patient beekeeper than men, as they think of what they want or how similar actions might impact their children. A typical response being, "I think I am much more hesitant to put a chemical in the hive than my husband is. And I know that that's because I'm a woman, but maybe I'm more cautious about what would impact my children" (Eleanor). Furthermore, Janet discusses how as a mother she views herself as a caretaker. This translates to her thinking of herself as the caretaker of her bees, a sentiment shared by other respondents.

In the third, follow-up interview, I asked participants if they thought their experiences were unique to them. Margaret and Rosemary both said that they do not think their struggles as beekeepers were unique to women. Fitting in with the earlier theme of gender not being important, they were more concerned about being welcomed by the larger beekeeping community. However, Rosemary said that she believes how she approaches solutions to beekeeping problems is unique, "I think the majority of beekeepers kind of already run into the same problems, but we just,

we just see it differently." Again, Rosemary connects this back to her motherhood, that she has to be creative in approaching her day-to-day as a work from home mom. Janet discusses how she is proud that she has had success keeping top bar hives, an uncommon alternative honey bee hive design, despite doubts from other beekeepers in her abilities to do so. Again, Janet does not think of this experience as unique to women, but rather unique to her. She does state at one point that other beekeepers doubted her success in keeping top bar hives, but the fact that she has had success in keeping her hives alive gives her pride. Furthermore, she feels pride that she built most of her hives herself, an experience she also believes to be less common as a woman.

There were two experiences that were deemed unique to women beekeepers but were only mentioned by one participant. Amelia noted issues with balancing being a new mom and a beekeeper, as well as having lift restrictions when pregnant the previous beekeeping season (2018).

> I'm a new mom and a beekeeper. It is impossible. It feels like it's impossible at times. And it's just to be able to, it's the same thing as like being, having a full time job and, and trying to juggle that...Well with the pregnancy is the inability to lift. I had wrist lifting restrictions for a while. Um, but that was one thing that like, thankfully I did have [husband], we did go out together...And he was able to do a lot of the heavy, heavy lifting and go out when I couldn't because of morning sickness or whatever.

Second, Kristin noted issues with finding gloves that fit, “I need extra small gloves and they're still too big and it's hard to find them.” These experiences do not fall into any theme, as they were only mentioned by one beekeeper. However, I documented these experiences as they might be shared by other beekeepers.

SQ 2: What is important to women beekeepers?

Community was by far the most important resource for women beekeepers. Eight beekeepers discussed becoming involved with beekeeping due to the help and support of their community. For some it was knowing that their family was interested and involved, “I had a cousin in Canada that wanted to [beekeep], and my mom's always shown interest and I always thought it was kind of fascinating. And so I thought, well if he [cousin] can do it in Canada, I can do it here” (Janet), having the support of their family or friends, “And so after the losses in the first year, we thought we better take a class. And so I went to class with him [husband] and that's when I first started to get interested” (Eleanor), or having the support of the local beekeeping community, “knowing that we would have their support through the Nebraska Beekeepers Association made it less intimidating that we would have people coming alongside of us, walking with us, and showing us were we screwing up” (Margaret). While community was important to these beekeepers, being a part of a women-dominated community was not as important. However, every beekeeper reported that respect, communication, and the ability to learn from the community was important in their selection and commitment to a beekeeping community.

Even though community was deemed important, three beekeepers, Kristin, Fiona, and Julia, were not involved in some form of beekeeping association. Every other beekeeper reported being involved with a local beekeeping association, some were even part of multiple local organizations, and every beekeeper mentioned consulting and relying on other beekeepers in their local communities for help and support. Seven beekeepers were still involved with beekeepers and mentors from these courses even though they were not actively partaking in a beekeeping course. Kristin and Georgia were the only two beekeepers to not mention taking a formal beekeeping course; Kristin specifically states she has not taken a beekeeping course, and Georgia does not discuss taking a formal beekeeping course, therefore I assume she has not taken one.

The three beekeepers who did care about gender ratio all had specific negative experiences they could recall. Janet noted issues with feeling disrespected when asking questions, Donna noted that she preferred consulting other women beekeepers who also face physical struggles lifting heavy hives boxes, and Amelia recalled multiple experiences of being ignored in favor of her husband by beekeepers. Again, most of these negative experiences stem from a lack of communication and acceptance from men beekeepers. Furthermore, most beekeepers did not care for social media communities, again due to a lack of knowledge sharing and respect within the pages. Some found that Facebook pages provided too much information to sift through. Others did not like the amount of bad or false information spread on the pages. While some had had negative

experiences with other beekeepers being mean on the pages. Some did not find the pages useful.

In our third follow-up interview, I asked beekeepers to list nouns with which they identify. It was my hope to understand some of their motivations through their identifiers. All three Research Participants that took part in the interview identified with the noun "mother." They all discussed that by being a mother they have to plan for the future, be attentive to their children, and use their intuition, which they also apply to their beekeeping. Janet summed it up as, "moms are kind of the keeper of the home, so to speak. So maybe it kind of, maybe it kind of relates to beekeeping in a way." From this, there continues to be a theme of motherhood connecting to their beekeeping.

Discussion

It is important to note that the experiences described here are not universal to all women beekeepers, and some of these experiences are shared with people who may not identify as a woman. Therefore, we must be careful in extrapolating these experiences to the larger public, as beekeepers are going to have different experiences based on where they live and with whom they interact.

A role that is important to the women beekeepers is the connection between keeping bees and motherhood. Nine of the beekeepers talked about motherhood during their involvement in the Women in Beekeeping program. Of the three beekeepers who did not discuss motherhood, two of those beekeepers do not have children. Five participants discussed the connection between motherhood and

beekeeping during their interviews. Beekeeping influenced the participants' relationships with others, and that their role as mothers played a role in their beekeeping.

In terms of relationships and beekeeping, Amelia mentioned the importance of being able to show her daughter that she can manage all of her responsibilities,

> I think it's really important, you know, having a daughter like to show her that women can be successful business owners and they can have a full time job and they can do all this other stuff and, and lead a healthy life.

Margaret shared a similar sentiment, as she and her daughter started beekeeping together. She enjoyed being able to share this experience with her daughter. Janet and her son also beekeep together and support each other. Olivia shared a similar experience with her step-father. She discusses how beekeeping has brought them closer together. All of these relationships demonstrate how the relationship with their family members was important to their beekeeping. Amelia, Margaret, and Eleanor describe how these relationships helped them persist in beekeeping. Furthermore, having the support of their family was important to a number of the beekeepers who are also mothers. The ability to share this experience with their family can be important to beekeepers and helping them persist through hardships.

I also noticed that participants' roles as mothers influenced their beekeeping. This emerged in terms of the beekeeper's concerns about chemicals in their hives, wanting to provide the best care for their bees, and care about the environment. Rosemary and Eleanor mentioned feeling more cautious than others in terms of what chemicals they apply in their colony and both connected this back to how they

would not want to needlessly apply chemicals to their family. For Eleanor, she discussed chemicals in terms of miticide treatments, “I think I am much more hesitant to put a chemical in the hive than my husband is. And I know that that's because I'm a woman, but maybe I'm more cautious about what would impact my children.” Whereas Rosemary talked about chemicals in terms of other pesticides and fungicides used by farmers nearby. Rosemary spent an extensive time discussing issues with chemical sprays near her apiaries and home. She even noted instances of her family being accidentally sprayed by aerial spray planes. Both women connected these feelings towards their caution and thought they put into considering what impacts their family.

Janet echoed the above sentiment during her interview. She discussed how she felt like she was the caretaker of her bees, just as she was the caretaker for her children. This connects to how many of these same mothers have strong familial relationships around their beekeeping. Furthermore, she discussed how she enjoyed that, in her opinion, there are more women promoting the different health benefits of honey bees, such as the use of pollen or propolis, and exploring more “natural” ways of beekeeping, “Women are the caretakers. So kind of like, because women have always kind of been seen that way. They can kind of promote it that way too as well.” For Janet, because women are viewed as caretakers by society, they are more able to explore and promote these aspects of beekeeping than men. Adding to this theme of mothers as caretakers of both the family and the hive, Rosemary discussed how the creative problem solving she uses as a mother to manage her kids schedule helps her manage her beekeeping. This fits in with the theme above, that mothers

will apply their instincts as a mother to their bees, exploring how and what is best for their bees.

Another theme that emerged was the physicality and cost of beekeeping. Donna mentioned that she is not sure if she could afford to beekeep if her husband was not around to build her hives, as pre-built hives cost more than hive bodies that a beekeeper must assemble. Seven of the participants talked about the difficulties of lifting heavy boxes. A deep box of honey can easily weigh sixty to seventy pounds, making it difficult to lift. Two beekeepers, Janet and Rosemary, keep bees in non-standard equipment. Rosemary keeps her bees in eight frame Langstroth boxes to make it easier for her to move. Janet keeps her bees in top bar boxes and while she did not mention starting top bars to make it easier physically, she does mention that not having to lift heavy boxes is a benefit of top bars. The physicality has been noted in the literature (Rogers, 2016). However, the difficulty of lifting heavy bee boxes has also been discussed by men beekeepers. During a hive inspection, Julia's husband said that he wished they would have started keeping bees in medium boxes, which are shallower and lighter than deep boxes (Figure 3.1). Other men beekeepers have mentioned it to different members of the research team as well. Therefore, the physical issues regarding beekeeping is an issue with beekeepers regardless of gender.

Figure 3.1

Two hives with two mediums, labeled with A, and two deep boxes, labeled with B

In terms of what is important to women beekeepers, the strongest theme was that they want to be accepted and feel welcome in their beekeeping communities. From the interviews, the presence of women in the program (and broader beekeeping community) was not as important of a factor than was anticipated. There were only three beekeepers who cared about the gender ratio of their beekeeping communities, and in two of those cases, they listed specific examples of being disrespected by men beekeepers. Amelia talked about how she is often "mansplained," by other men in the beekeeping association. Mansplaining is a term used to describe when a man explains something to a woman in a condescending tone. Janet discussed how in some of her interactions with men, she feels a bit inferior and talked about how some men do not take her seriously as a beekeeper. Within both Janet and Amelia's responses, they have had positive and negative

interactions with men. Janet has positive interactions with her instructor. Amelia, although not evident in her quote, has had positive interactions with other men in her local beekeeping association.

Janet describes her negative interactions with men in her first interview, but in her second interview talks more about her interactions with an all women beekeeping Facebook group, "Yeah I like to go on the women one [Facebook group] And no one's really critical. And if anyone is, she [The Page Administrator] zaps them out of there, whoever is the administrator of the thing, she blocks them." Again, the issue is not necessarily related to gender, but more so having a friendly, respectful community. Amelia discusses a similar issue leaving the same Facebook that Janet discusses, because of her experiences,

> I think it's [Facebook group name redacted] and um, it got nasty really, really fast and I could like, I could feel my blood pressure rise with some of the posts. And it was, they were sharing incorrect information...And then just people, just attack. So it just got, it got really nasty.

This is common in general farming communities, where women are frustrated by farming communities because they felt they were not taken seriously and disrespected by other men (Trauger, 2004). Women then form their own spaces as a way to feel less isolated from the farming community, but also have a group that meets their needs and welcomes them (Sachs et al., 2016; Shortall, 1996). The issue is not necessarily with men, but with people who are habitually disrespectful and mean towards women. Therefore, I argue that feelings of being accepted is not

always an issue related to sexism or gender, but is more a sense of mutual respect, welcoming, and valuing the merit of contributions regardless of one's gender.

Further confirming this idea, I note that a majority of the beekeepers did not report gender ratio as being important to their beekeeping community. Instead they reported that they wanted communities that were welcoming, accepting, and knowledgeable. This further supports the idea that the issue with beekeeping communities is not necessarily men, but rather with those who do not treat women as equals. Nine out of twelve of the participants did not consider the gender ratio of a group when joining a beekeeping community. This is likely because the beekeeping communities they were joining did not treat them differently for being women. We as educators need to continue to encourage beekeeping communities to focus on providing a good education, as well as open, welcoming communities.

These positive experiences within beekeeping communities contrast the mostly negative experiences documented by women farmers (Brasier et al., 2009; Trauger, 2004; Sachs et al., 2016). Part of the reason why there is not the same issue of sexism that has been found in farming communities might be due to the gender ratio of these groups. Only 28% of Nebraskan farmers are women (United States Department of Agriculture, 2017), compared to almost half (49.77%) of Nebraskan beekeepers are women (S. Brummel, personal communication, September 21, 2020). Additionally, I estimate at least half of beekeeper educators and extensionists are women. Therefore, having more equal gender ratios may equate to there being less of a stigma surrounding women beekeepers in Nebraska and surrounding states.

Another reason that women beekeepers in our study reported fewer issues with sexism compared to women farmers in the literature, may be due to the long history of women in beekeeping. Historically, women have been encouraged to beekeep by important beekeepers such as Lorenzo Langstroth and A.I. Root (A.I. Root Company, 1906; Horn, 2012). In the early 1900's many women kept bees as a way to supplement their household income (Horn 2010). However, it is unique that women beekeepers are more accepted than their farmer counterparts. Women have long been a part of beekeeping, and while this does not erase some of the issues and barriers women beekeepers face, it does normalize the idea that women and men both belong in beekeeping.

Recommendations

I examined women beekeepers as a way to learn more about the potential barriers and needs of this population, as there is a growing number of women beekeepers (Aubrey, 2010). In Nebraska, half of our beekeepers attending educational programs identify as women (S. Brummel, personal communication, September 21, 2020). Since a beekeeper's education is important for the survival and care of their hives (Findlay et al., 2015; Jacques et al., 2017), the hope is to use what I have learned here to better design beekeeper education programs to be more inclusive of women. While I did not find that gender segregated events were of major importance in our women study participants, it may be important to others in different geographical locations.

Before deciding on whether to create an event for a specific gender, it will be important to ask participants if the community needs that space. Some of the negative experiences mentioned by the participants occurred with well-respected leaders of the Nebraska beekeeping community. These are people that interact and often help beginner beekeepers but did not leave good impressions on the program participants. For example, Janet noted having trouble with a leader in the beekeeping community because she does not keep standard 10-frame Langstroth hives. She needed someone who was willing to help her. Therefore, asking participants what they need from the community - mentors, education on keeping bees in different hive bodies, treatments, etc., and ensuring that the leaders of the beekeeping community are willing and able to meet these needs, will be an important first step in improving educational programming. By doing so, it will help to ensure beekeepers feel comfortable within their beekeeping community.

Beekeeping programs should also attend to fostering and building relationships within the beekeeping community. The beekeepers strengthened their relationships with others through beekeeping, especially their familial relationships. These relationships likely flourish because the women are working with a family member who they trust. Trust is important in building relationships within public organizations (Cho & Park, 2011). In terms of agriculture, trust between educational institutions and agriculturists can be important in helping agriculturists adopt new practices, such as legitimizing sustainable farming practices for farmers (Carolan, 2005). Collaboration that is based on trust between multiple interest groups is also important in building good relationships (James, 2002). The beekeepers in this

program built trusting, collaborative relationships around beekeeping with other members of their family. These relationships helped them remain interested in beekeeping and overcome hardships that they experienced. By building a trusting, collaborative relationship between all involved parties (beekeepers, extensionists, and researchers), educators can aid beekeepers in their future beekeeping endeavors.

Future Directions

Future research needs to further investigate the wants and needs of women beekeepers. One such investigation includes documenting the experiences of women beekeepers outside of the state of Nebraska. This research examined nine women from Central and Eastern Nebraska, two women from Iowa and one woman from Kansas. Therefore, the results of this research can only be used to explain phenomena found within these geographic locations. The experiences of women beekeepers in different regions may be different from those in this study. Future studies should take the results of this work into account but attend to culture surrounding women located in different regions of the United States.

A number of the beekeepers discussed how they believe women move more slowly and calmly than men when beekeeping. This sentiment has been noted anecdotally by members of our research team and is widely believed within the beekeeping community (Burlew, 2018). Bees tend to respond better to slower and smoother movements. Quick, choppy movements are known to anger bees while beekeeping. Putting empirical data to this idea that women move differently than

men while beekeeping could be useful in teaching beekeepers to move in ways that are less disturbing to their bees. Continuing to examine the difference between men and women beekeepers may be of importance to help us better understand beekeeper behavior.

Other future research projects should further examine beekeeping communities. Participants and non-program participants both mentioned the importance of participating in beekeeping communities. These communities enabled beekeepers to learn from others and build trusting relationships with program facilitators and educators. As beekeeping communities appear to be an important part of women beekeeper's sense of enjoyment in beekeeping and acceptance by peers more research in this area can help to provide better on how to meet the needs of women beekeepers.

As stated earlier in this chapter, there is a lack of data on beekeepers of all genders. Yet, this data could be useful in understanding what beekeepers need. By connecting researchers to their local beekeeping communities, they can build better relationships with the local beekeepers, and collaborate with beekeepers regarding research and education. There are organizations focused on bringing together apiculturists, beekeepers, and state apiarists, such as the American Association of Professional Apiculturists, but research on beekeeping communities is still scarce. By connecting with the Nebraskan beekeeping community, I have been able to help modify the beekeeper educational programming provided by the University of Nebraska-Lincoln. I can now also provide insight into why some beekeepers are utilizing certain management techniques. Beekeeping communities are a largely

untapped source of information. Continuing to understand their function and what they provide to beekeepers can be key in understanding the actions and behavior of beekeepers.

References

A.I. Root Company. (1906). *Bee-keeping for women.*

Aubrey, A. (2010). Healing honey and the new Queenbee(keepers). *National Public Radio.* https://www.npr.org/2010/07/19/128574280/healing-honey-and-the-new-queen-bee-keepers.

Bancheva, E., and Ivanova, M. (2015). Informal learning in the workplace. In *Private World(s): Gender and Informal Learning of Adults* (pp. 157-182). Rotterdam: Sense Publishers.

Brasier, K., Barbercheck, M., Kiernan, N.E., Sachs, C., Schwartzberg, A., & Trauger, A. (2009). Extension educators' perceptions of the educational needs of women farmers in Pennsylvania. *Journal of Extension, 47(3),* 3FEA9.

Burlew, R. (2018). Are women better beekeepers. *American Bee Journal*, *159(*7), 801-804.

Carolan, M.S. (2006). Social change and the adoption and adaptation of knowledge claims: Whose truth do you trust in regard to sustainable agriculture? *Agriculture and Human Values, 23,* 325-339. https://doi.org/10.1007/s10460-006-9006-4.

Colopy, M. 2015. Women in beekeeping. *Bee Culture.* https://www.beeculture.com/women-in-beekeeping/

Cho, Y.J., & Park, H. (2011). Exploring the relationships among trust, employee satisfaction, and organizational commitment. *Public Management Review, 13(*4), 551-573. https://doi.org/10.1080/14719037.2010.525033

Creswell, J.W., & Moerer-Urdahl, T. (2004). Using transcendental phenomenology to explore the "ripple effect" in a leadership mentoring program. *International Journal of Qualitative Methods, 3(*2), 19-35. https://doi.org/10.1177/160940690400300202.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing among five approaches.* SAGE Publications.

Findlay, J.R., Eborn, B., & Jones, W. (2015). Effects of colony creation method and beekeeper education on honeybee (*Apis mellifera*) mortality. *Journal of Extension, 53(*1), 1RIB6.

Horn, T. (2010). Women & Beekeeping in Longstroght's Time. *Bee Culture, 138(*6), 16-18.

Horn, T. (2012). *Beeconomy: What Women and Bees can Teach Us about Local Trade and the Global Market.* University Press of Kentucky.

Jarosz, L. (2011). Nourishing women: toward a feminist political ecology of community supported agriculture in the United States. *Gender, place and culture,* 18(3), 307-326. https://doi.org/10.1080/0966369X.2011.565871.

Jacques, A., Laurent, M., EPILOBEE Consortium, Ribière-Chabert, M., Saussac, M., Bougeard S., Budge, G.E., Hendrikz, P., & Chauzat, M. (2017). A pan-European epidemiological study reveals honey bee colony survival depends on beekeeper education and disease control. *PLoS ONE, 12(*3), e0172591. https://doi.org/10.1371/journal. pone.0172591.

James, S. (2002). Bridging the gap between private landowners and conservationists. *Conservation Biology, 16(*1), 269-271.

https://doi.org/10.1046/j.1523-1739.2002.01039.x.
Lave, J. (1991). *Situating learning in communities of practice.* In L.B. Resnick, J.M. Levine, & S.D. Teasley (Eds.), Perspectives on socially shared cognition (pp. 63-82). American Psychological Association.
Litchman, M. (2013). *Qualitative research in education* (3rd ed.). SAGE Publications.
Macoloo, C., Recha, R., Radeny, M., & Kinyangi, J. (2013). Empowering a local community to address climate risks and food insecurity in Lower Nyando, Kenya. *Case Study prepared for Research Program on Climate Change, Agriculture and Food Security.*
Mburu P., Affognon, H., Irungu, P., Mburu, J., & Suresh, R. (2015). Beekeeping for women empowerment: Case of commercial insect programme in Kitui County, Kenya. *Conference Paper: International Association for Feminist Economics.*
Moustakas, C. (1994). *Phenomenological Research Methods*. SAGE Publications.
Neumann, W.L. (2011). *Social research methods: Qualitative and quantitative approaches* (7th ed.). Pearson.
Ogaba, M.R. (2001). Gender issues in beekeeping: the Uganda case. *Apidmondia International Apicultural Congress.* Durban, South Africa.
Plano Clark, V.L., & Ivankova, N.V. (2016). *Mixed methods research: A guide to the field.* SAGE Publications.
Rogers, K. (2016). The beeyard ain't no place for a woman: female beekeepers of grey and bruce. *Ontario Bee Journal.*
Sachs, C.E., Barbercheck, M.E., Brasier, K.J., Kiernan, N.E., & Terman, A.R. (2016). *The Rise of Women Farmers and Sustainable Agriculture.* University of Iowa Press.
Saldaña, J. (2013). *The coding manual for qualitative researchers.* SAGE Publications.
Shortall, S. (1996). Training to be farmers or wives? Agricultural training for women in Northern Ireland. *Sociologia Ruralis, 36(*3), 269-285. https://doi.org/10.1111/j.1467-9523.1996.tb00022.x.
Smith, J.A., Flowers, P., & Larkin, M. (2009). *Interpretative Phenomenological Analysis: Theory, Method, and Research.* SAGE Publications.
Sperandio, G., Simonetto, A., Carnesecchi, E., Costa, C., Hatjina, F., Tosi, S., & Gilioli, G. (2019). Beekeeping and honey bee colony health: A review and conceptualization of beekeeping management practices implemented in Europe. *Science of the Total Environment, 696(*15), 133795. https://doi.org/10.1016/j.scitotenv.2019.133795.
Trauger, A. (2004). 'Because they can do the work': women farmers in sustainable agriculture in Pennsylvania, USA. *Gender, Place and Culture, 11(*2), 289-307. https://doi.org/10.1080/0966369042000218491
Trauger, A., Sachs, C.E, Barbercheck, M.E., Kiernan, N.E., Brasier, K.J., & Findeis, J. (2008). Agricultural education: gender identity and knowledge exchange. *Journal of Rural Studies, 24*, 432-439. https://doi.org/10.1016 /j.jrurstud.2008.03.007.
United States Department of Agriculture. (2017). Nebraska: State and County Data. *2017 Census of Agriculture.*
Van Manen, M. (1990). *Researching Lived Experience: Human Science for Action Sensitive Pedagogy.* The State University of New York Press.

World Bank. (2017). Women in agriculture: the agents of change for the global food system. https://www.worldbank.org/en/news/feature/2017/03/07/women-in-agriculture-the-agents-of-change-for-the-food-system.

Chapter 4: Conclusions

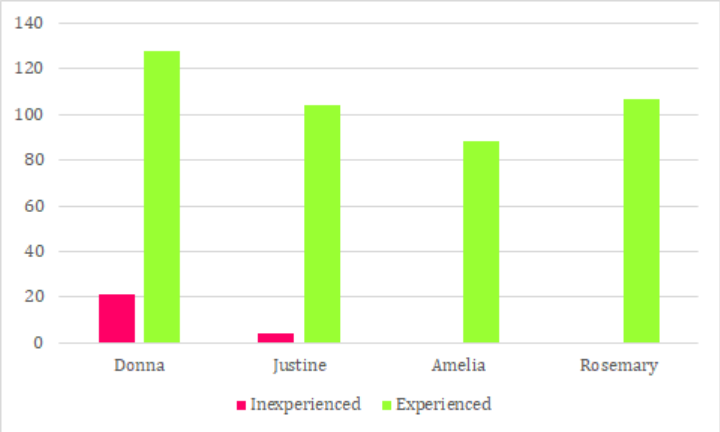
The availability of a community, both online and in-person, was important to all of the participants. Some members enjoyed having online access to the Women in Beekeeping program content. Janet specifically mentioned watching the videos when she could not attend in person. Fiona mentioned watching the videos multiple times to review the material. Julia watched a number of the learning circles over Zoom and talked about how she enjoyed not having to rush from work to attend the learning circle in-person, rather she was able to watch online as she ate dinner. From this information, it is important to provide convenient access to program materials online for learners even in conjunction with in-person learning opportunities. Multiple modes of access will better accommodate learners and may lead to better satisfaction in the learning experience.

From this work, I have evidence to support that developing beekeeping communities aids beekeepers in better hive health management. Beekeepers in the program who were more involved in the local beekeeping community performed fewer inexperienced beekeeping actions than those who had the same years of beekeeping experience (Figure 4.1). Donna, Justine, Amelia, and Rosemary all had comparable years of experience beekeeping (8, 5, 9, and 4 respectively), but they did not all have the same level of experienced and inexperienced actions. The also had differing involvement in the beekeeping community. Donna had noticeably more inexperienced actions, even though she has been beekeeping for eight years. However, Justine, Amelia and Rosemary are all extremely involved in the beekeeping community, both within and outside of the Women in Beekeeping

program. They performed relatively lower numbers of inexperienced actions, indicating that they may be accumulating better beekeeping techniques by being more involved in the community. Donna, who was not as involved in the beekeeping community outside of the Women in Beekeeping program, demonstrated the highest number of inexperienced beekeeping actions. Therefore, it is important to encourage involvement in beekeeping communities as this may impact beekeeping practices.

Figure 4.1

Comparison of the total number of actions performed throughout the beekeeping season for Donna, Justine, Amelia, and Rosemary



Note. All beekeepers are experienced beekeepers. Donna, however, is the only beekeeper who is not involved in other beekeeping communities.

Lastly, I encourage researchers to continue examining beekeeping communities. Communities are a source of information for people (Lave, 1991). I have found that the Women in Beekeeping program gave beekeepers with different

resources than social media pages and other local associations provide. These resources are not necessarily better or worse, but they do provide additional and easily accessible information outside of formalized beekeeping education programs. More research in this area can help identify the different needs and barriers to beekeepers and what learning experiences they need in these communities.

While gender was not a pronounced barrier to the beekeepers in the Women in Beekeeping program, literature reports some women beekeepers experience sexism. Commercial beekeepers in Ontario have discussed barriers in beekeeping that occur due to their gender (Rogers, 2016). In our program, Janet and Amelia discussed having issues with men beekeepers. Additional research and examining beekeeping communities and experiences of women beekeepers may be key for understanding and implementing strategies to overcome these barriers. Additionally, by understanding what is provided to beekeepers by their local community, educators can help fill in the gaps in beekeepers' knowledge and management practices.

Role of Mentorship

When the research team first designed the Women in Beekeeping program, the intention was for participants to attend the learning circles as their primary educational experience. I would only participate as a silent data collector. However, this did not happen. When observing the program participants inspect their hives, participants asked me questions about their management activities, the health of their colonies, and how to improve their ability to inspect their hives. I could not

ignore these questions as I wanted to build a trusting relationship with the participants. I also thought it was unfair to deny them suggestions and teaching on science-based beekeeping strategies. In doing so, I decided to embed myself within the research. While this was not the original intention, the program participants reacted well to this interaction. They enjoyed having me there to help lift boxes, discuss short and long-term management strategies, and provide hands-on learning. For example, Janet, Kristin, Fiona, and Margaret all asked me to show them how to perform a powder sugar roll to evaluate *Varroa* populations in their hives. I was able to provide the beekeepers with a learning experience similar to what a mentor would provide. This ended up being a valuable source of bee management education that reinforced the concepts presented in the program's learning circles.

Mentorship is a way to pass down knowledge, this can occur in an informal or formal fashion (Nudell, 2019). In the case of this research project, the mentorship was informal and unintended. Mentorship correlates with increased job satisfaction and career advancement for the mentee, often because they are learning job skills from their mentor (Underhill, 2006). Learning from me during hive inspections likely correlates with some of the increases in program participant knowledge, self-efficacy, and colony health. While I did not study the correlation between this unintended mentorship, the beekeepers recognized that this experience helped them learn beekeeping techniques and was of value in improving satisfaction in the program

Future beekeeping education programs should capitalize on the value of mentorship. A more formalized and intentional program may be necessary as both

mentees and mentors often have difficulty recognizing a mentorship relationship (Welsh, Bhave, & Kim, 2012). As there is much inaccurate and conflicting information in beekeeping, mentors need to be experienced and should promote scientifically-supported bee management practices. Furthermore, mentors should be accessible and ideally situated within short driving distance to mentees. Justine talked about how she struggled in finding a mentor when she first began beekeeping who lived close enough to be willing to drive and help her with her bees. Therefore, future educational programs need to use mentors that are well trained and live throughout the state. Alternatively, a dedicated apiary inspector or extension staff member that is dedicated to mentoring beekeepers could travel throughout a region to work with beekeepers in their apiaries.

Addressing Anti-Science Sentiments in Beekeeping

A number of the non-program participants gave responses that indicated they do not trust or have confidence in science. Such responses were directed at the researchers stating that we were ill-equipped to conduct research on honey bees. For example, one non-program participant said:

> Listen, climate change or "long-term erratic weather patterns" are not scientific terms, they are economic terms. When you figure out who is trying to lead you around by the nose hairs and what they are trying to cheat you out of, then you can move on and actually focus on REAL scientific knowledge. Good luck kiddo.

Another example includes, “The best I can do is manage the harm they [*varroa*] cause and hope ‘science’ doesn’t make it worse by creating the next superbug.” Similarly, other anti-science sentiments by non-program participants were fear-based. A number of non-program participants used the word “poison” to discuss pesticides with a typical response being, “The poisons people dump into the environment are the scariest thing for me.” The non-program participants were frightened of pesticides and other agrochemicals. While some of these fears may be founded in previous experiences with pesticides killing their colonies, beekeepers need to be educated on the topic, not fearful. These anti-science sentiments stand in stark contrast to the program participants who trusted me as a scientist and let me into their lives.

Part of this might be the populations of beekeepers I reached. While a majority of the program participants were on Facebook and other social media pages for beekeeping, most of them were indifferent about their use of social media and showed little involvement on these social media pages. Whereas most of the recruiting for non-program participants occurred on beekeeping pages on Facebook. The populations who use Facebook pages for information may tend to skew more towards anti-science sentiments, as social media sites are known for making it easier to spread misinformation (Nguyen et al., 2012), and therefore, there may be some volunteer bias in who volunteered for our survey.

Additionally, Fiona contacted the research team prior to her last beekeeping inspection to ask us about how to find good, reliable beekeeping information. Her dilemma was that during the program, she was able to contact me, however, after

the program ended I would be unable to provide as much assistance. I shared with her where to find reliable beekeeping information, and how to evaluate information found on the internet. While I was able to help Fiona find resources to continue learning about beekeeping, the Women in Beekeeping program did not cover this topic during the 2019 learning circles.

After participating in the program, participants reported using web forums more often than before their participation in the Women in Beekeeping program (Table 2.11). Program participants also reported using academic journals as a source of beekeeping information more often than non-program participants (Table 2.11). Again, this could be a bias in the populations of beekeepers that volunteered for the research project. The beekeepers of Nebraska, especially those close enough geographically to volunteer for this research project, have regular access to a university bee lab. Given the regular interactions they had with me and other members of the UNL Bee Lab, the program participants might be more apt to look for scientifically-backed information based on factors outside of the Women in Beekeeping program.

Providing information on additional resources on honey bee management and other educational opportunities is critical to continue to support program participants. Further, it is necessary to provide guidance on how to look for and evaluate information on beekeeping that is science-based. From my experience, an estimated 30% of the information found on online beekeeping forums and social media is pseudo-scientific. To fully understand these anti-science sentiments, and provide better and science-based beekeeping information, we need to not only

create and share beekeeping resources, but also gain the trust of the beekeeping community. Lave (1991) discusses how learning is socially situated, meaning an educator not only needs to focus on educational content, but also embed and understand the culture in which their students are learning. One way to achieve this would be to become active in communities on social media and sharing success and advantages of science-based beekeeping management practices. I again emphasize the importance of conducting more research into the beekeeping community in this area. This can help extensionists and researchers better understand what is needed from their educational programs and counter pseudo-scientific attitudes and beekeeping practices.

Role of Values

As discussed in chapter two, one of the reasons that the program participants performed similarly to the non-program participants was due to the value system of the program participants. The non-program participants were more experienced than the program participants, but the two groups performed the same in terms of management, self-efficacy, and colony health. Ideally, I would argue the program participants are performing at a similar level due to their involvement in the Women in Beekeeping program. However, more of the program participants viewed their honey bees as pets or wild animals than the non-program participants. How one views their honey bees may impact how they treat their honey bees. Someone who takes a more utilitarian approach, defined by Kellert (1996), is more likely to focus on how their honey bees can benefit them, whereas someone taking a more

humanistic approach is more likely to emotionally bond to their honey bees. Taking a more humanistic approach to honey bees may lead to beekeepers being more attuned to the needs of their honey bees and of the larger environment around them. This could potentially explain why the program participants were able to answer questions regarding pollination biology better than the non-program group. Similarly, this may also connect to how the program participants connected their motherhood to their beekeeping.

Six of the program participants talked about motherhood during their involvement in the program. Of the three beekeepers who did not discuss motherhood, two of them did not have had children. The major themes discussed in relation to motherhood were the familial relationships around beekeeping and feelings of being a caretaker for the bees - similar to their feelings as a mother (Table 4.1). Of the four women who talked about being a mother, three of them consider honey bees to be wild animals. Amelia was the only one that did not think of honey bees as wild animals or pets. Instead she listed them as livestock. This may be because she runs a small business on the honey and other products produced by her honey bees.

The role of motherhood may also influence how women think of and treat their honey bees. By viewing their honey bees as wild animals instead of livestock, they are taking a more humanistic approach to their honey bees. Part of the reason for this bond to their bees could be that they view themselves as the “mother” to their honey bees. For example, some of the participants who were also mothers reported that they viewed themselves as a caretaker to their honey bees and made a

parallel connection to their care of the honey bees and their role as mothers. Other participant mothers mentioned being more cautious about where they place their hives so they would protect them from harm by errant pesticides. Being emotionally bonded to their honey bees and viewing themselves as caretakers is influencing how these beekeepers are managing their hives. This is further supported in the literature as studies show that that beekeeper's values influence their management (Underwood, Traver, & López-Uribe, 2019).

Table 4.1

Program participant responses about how they think of bees, and themes regarding motherhood and beekeeping

Program Participant	What do you consider honey bees to be?	Motherhood themes
Janet	Wild Animals	Caretaker
Margaret	Wild Animal	Relationships
Amelia	Livestock	Relationships
Rosemary	Wild Animal	Caretaker

Note. The two themes emerged when describing their honey bees and their relationship to them. The two motherhood themes are describing their duty as caretaker or sharing a mother-child relationship with their bees.

Another important value that emerged from my research is the desire of beekeepers to use non-chemical based or alternatives treatments to deal with honey bee pests and diseases. Currently, parasites like *Varroa* are largely managed by

regulated pesticides and accompanying non-chemical cultural management practices. Both program and non-program research participants reported that they desire and are actively seeking non-chemical and "natural" based tools to deal with pests like *varroa*. I believe this desire for natural treatments is similar to how consumers tend to buy more "natural" foods because they perceive these foods to be better and healthier (Moscato & Machin, 2018). However, this may also connect back to the beekeeper's value system. Beekeeper's values tend to influence whether beekeepers use chemical treatments in their hives (Underwood, Traver, & López-Uribe, 2019). If beekeepers are emotionally bonded to their bees, they are likely to be more careful about what they are doing to manage their hives to avoid colony death. Given that many pesticides and other chemicals used in fields and lawns where bees forage cause harm to bees (Zhu et al., 2014), and even though miticides are tested to ensure they do not harm honey bees, beekeepers who view their bees as something other than livestock may be more apt to look for non-chemical alternatives. Furthermore, beekeepers that tend to think of their honey bees as something other than livestock may be more likely to look for alternative means to treat parasites and honey bee diseases.

However, regardless of the availability of scientifically-backed management strategies, beekeepers have a long history and an active online community supporting the use of "experimental" and pseudo-scientific beekeeping practices. Many beekeepers experiment with "word-of-mouth" treatments for parasites, pests, and diseases. Sometimes this is done out of necessity as beekeepers do not know what else to do, do not have the right equipment to implement certain management

strategies or do not have access to ask for expert's advice. For example, Janet, who uses top bars, struggled with applying chemical *Varroa* treatments because those treatments are only made for 10-frame Langstroth hives. Therefore, she had to experiment with the application of the chemical treatments to fit her unique hive situation. However, other beekeepers may "experiment" because they are against using chemical treatments. This could be due to mistrust of the chemicals, concerns with personal safety due to exposure to chemical treatments, or may relate back to how they view themselves as caretakers of the bees. I also found apprehension and distrust in chemical treatments and the damage that they might do to the environment in many of our participants' responses. Additionally, some respondents expressed their disdain for researchers looking into pest treatments, with some beekeepers stating their worry that science will create "superbugs" that will continue to hurt bee colonies. Researchers should continue to investigate a variety of management strategies for hives, that includes chemicals and non-chemical alternatives, so beekeeper have options in terms of managing for pests. There also needs to be additional work done investigating the role that beekeeper's values play and the choices that they make managing their bees.

Continuing with the role of values in beekeeping, this may also explain some of the perceived differences between men and women beekeepers. Anecdotally, it is thought that women beekeepers are more gentle and delicate with their honey bees than men (Burlew, 2018). This is also discussed by the participants in this research, and is widely believed within the beekeeping community, even though there is no empirical data to support these claims. Part of the explanation for these perceived

differences could be that more men beekeepers are also commercial beekeepers, and therefore do not have the time when inspecting and working hundreds of hives to be gentle. However, it may also be differences in the value systems of men and women. Agricultural literature shows that men and women farmers have different educational values and learning styles (Bancheva & Ivanova, 2015; Brasier et al., 2009; Kiernan, 2012). Women may have a stronger emotional connection to their bees than men if women are thinking of themselves as the caretaker or mother to their bees, especially if, like a majority of the participants, they are small-scale beekeepers. This may lead to differences in management strategies, as suggested by Eleanor who points out that she is more hesitant using chemicals in her bee hives than her husband because she is a mother. A future area of investigation may be examining if women beekeepers and men beekeepers have different values systems, which then lends itself to different beekeeping management strategies.

Future Research

The success of a honey bee colony is reliant on many different factors, management (Sperandio et al., 2019), beekeeper knowledge (Findlay, Eborn & Jones, 2015), availability of nectar and pollen resources (Alaux et al., 2010; Grandi-Hoffman et al., 2016; Keller, Fluri & Imdorf, 2005), pesticides in the environment (Traynor et al., 2016), and pests (Zawisklak, 2019). These factors all interact with one another making it difficult to evaluate the impact of the Women in Beekeeping program on honey bee management and beekeepers. For example, I attempted to measure both management and hive health as a way to determine which changes come as a result

of changes in beekeeper management or just general fluctuations in hive health. Ultimately, I was not able to fully determine what caused some of the changes in the participants over time. Hive health is affected by many factors, some of which are out of the control of the beekeeper. In my study, some beekeepers received their packaged bees, used to start their colonies, very late in the spring. These 'late-started' hives faced many challenges as a result. Hive health can also fluctuate greatly with each season, even with good management practices. This means I need more long-term data to fully understand the influence of beekeeping practices. My study does provide some evidence that participants who were more involved in the beekeeping community were better at inspecting their colonies, and the hives of more experienced beekeepers were healthier. Additionally, participants with good land resources also appeared to have healthier colonies. It may be that if the land provides enough resources, management may not matter as much in terms of hive health. Given that all of these factors are assumed to be interrelated, future research needs to examine how much of colony health is dependent on beekeeper management, land resources, and beekeeper knowledge.

Additionally, a major theme within the beekeeper's experiences was the role of motherhood, family, and beekeeper values. Program participants referred to their honey bees as pets or wild animals more than the non-program participants. Beekeeper's philosophy regarding the use of chemicals to control pests and pathogens correlates with the use of chemicals within the hive (Underwood, Traver, & López-Uribe, 2019). I expect that other values of beekeepers, such as if they think of honey bees as pets, wild animals, or livestock, influences their beekeeping

management style. This may be key in explaining some of the differences in knowledge, self-efficacy, and management between the program participants and non-program participants.

This study also found some evidence of strong pseudo-science practices and attitudes towards bee management. More research should be done to see if there is a link between pseudo-science management practices and colony health. Not providing adequate care for a bee colony can negatively impact the hive's health (Sperandio et al., 2019). Previous literature shows that a beekeeper's philosophies influenced their use of in-hive chemicals (Underwood, Traver, & López-Uribe, 2019). Therefore, there may be other associations between beekeeper's beliefs and attitudes towards sciences, what management strategies they implement, and how the use or non-use of management strategies impact colony health. Future work should explore the impact of beekeeper's values and relationship to honey bees and its impact on honey bee management practices.

References

Alaux, C., Ducloz, F., Crauser, D., & Le Conte, Y. (2010). Diet effects on honeybee immunocompetence. *Biology Letters, 6(*4), 562-565. https://doi.org/10.1098/rsbl.2009.0986.

Bancheva, E., and Ivanova, M. (2015). Informal learning in the workplace. In *Private World(s): Gender and Informal Learning of Adults* (pp. 157-182). Rotterdam: Sense Publishers.

Brasier, K., Barbercheck, M., Kiernan, N.E., Sachs, C., Schwartzberg, A., & Trauger, A. (2009). Extension educators' perceptions of the educational needs of women farmers in Pennsylvania. *Journal of Extension, 47(3),* 3FEA9.

Burlew, R. (2018). Are women better beekeepers. *American Bee Journal*, *159(*7), 801-804.

Findlay, J.R., Eborn, B., & Jones, W. (2015). Effects of colony creation method and beekeeper education on honeybee (*Apis mellifera*) mortality. *Journal of Extension, 53(*1), 1RIB6.

Grandi-Hoffman, G., Chen, Y., Rivera, R., Carroll, M., Chambers, M., Hidalgo, G., & Watkins de Jong, E. (2016). Honey bee colonies provided with natural forage have lower pathogen loads and higher overwinter survival than those fed protein supplements. *Apidologie, 47,* 186-196. https://doi.org/10.1007/s13592-015-0386-6.

Keller, I., Fluri, P., & Imdorf, A. (2005). Pollen nutrition and colony development in honey bees: Part 1. *Bee World, 86(*1), 3-10. https://doi.org/10.1080/0005772X.2005.11099641.

Kellert, S. R. (1996). *The value of life: biological diversity and human society*. Island Press/Shearwater Books.

Kiernan, N.E., Barbercheck, M., Brasier, K.J., Sachs, C., & Terman, A.R. (2012). Women farmers: Pulling up their own educational boot straps with extension. *Journal of Extension, 50(*5), 5RIB5.

Lave, J. (1991). *Situating learning in communities of practice.* In L.B. Resnick, J.M. Levine, & S.D. Teasley (Eds.), Perspectives on socially shared cognition (pp. 63-82). American Psychological Association.

Moscato, E.M., & Machin, J.E. (2018). Mother natural: Motivations and associations for consuming natural foods. *Appetite, 121,* 18-28. https://doi.org/10.1016/j.appet.2017.10.031.

Nguyen, N.P., Yan, G., Thai, M.Y., & Eidenbenz, S. (2012). Containment of misinformation spread in online social networks. *Conference: Proceedings of the 3rd annual ACM web science conference,* 213-222. https://doi.org/10.1145/2380718.2380746.

Nudell, N. (2019, April). *Methods in mentoring: Mentoring models.* EMS World. https://www.emsworld.com/article/1222438/methods-mentoring-mentoring-models.

Rogers, K. (2016). The beeyard ain't no place for a woman: female beekeepers of grey and bruce. *Ontario Bee Journal.*

Sperandio, G., Simonetto, A., Carnesecchi, E., Costa, C., Hatjina, F., Tosi, S., & Gilioli, G.

(2019). Beekeeping and honey bee colony health: A review and conceptualization of beekeeping management practices implemented in Europe. *Science of the Total Environment, 696(*15), 133795. https://doi.org/10.1016/j.scitotenv.2019.133795.

Traynor, K.S., Pettis, J.S., Tarpy, D.R., Mullin, C.A., Frazier, J.L., Frazier, M., & vanEngelsdorp, D. (2016). In-hive pesticide exposome: Assessing risks to migratory honey bees from in-hive pesticide contamination in the Eastern United States. *Scientific Reports, 6,* 33207. https://doi.org/10.1038/srep33207.

Underhill, C.M. (2006). The effectiveness of mentoring programs in corporate settings: A meta-analytical review of the literature. *Journal of Vocational Behavior, 68(*2), 292-307. https://doi.org/10.1016/j.jvb.2005.05.003.

Underwood, R.B., Traver, B.E., & López-Uriber, M.M. (2019). Beekeeping management practices are associated with operation size and beekeepers' philosophy towards in-hive chemicals. *Insects, 10(*1), 10. https://doi.org/10.3390/insects10010010

Welsh, E.T., Bhave, D.P, & Kim, K.Y. (2012). Are you my mentor? Informal mentoring mutual identification. *Career Development International, 17(*2), 137-148. https://doi.org/10.1108/13620431211225322.

Zawisklak, J. (2019). *Honey Bee Health.* University of Arkansas System Division of Agriculture Cooperative Extension Service. https://www.uaex.edu/publications/pdf/MP547.pdf.

Zhu, W., Schmehl, D.R., Mullin, C.A., & Frazier, J.L. (2014). Four common pesticides, their mixtures and a formulation solvent in the hive environment have high oral toxicity to honey bee larvae. *PLoS One, 9(*1), e77547. https://doi.org/10.1371/journal.pone.0077547.

Appendix A: Hive Inspection Sheet

Beekeeper: Inspection #: Date:

Weather:

# of boxes: Frames of bees:

Type of boxes:

Brood pattern: Good Fair Poor

Eggs: Y/N Queen: Y/N Demeanor: Calm Nervous Aggressive

Resources:

Pollen Diversity: Adequate amount for Brood:

Diseases/Pests:

Treatment (if any):

Notes:

Appendix B: Definition of Mixed Methods Research

Generally, mixed methods research is an approach that utilizes both quantitative and qualitative research methodologies to provide a broader perspective and deeper understanding of research questions (Creswell et al., 2013; Greene et al., 1989). Mixed methods research is here defined as a research method that integrates rigorous quantitative and qualitative research constructs to draw conclusions regarding the research questions or purposes. The key factors of this definition are the inclusion of quantitative and qualitative methods and the usage of the word "rigor." "Rigorous" implies the need for deliberate data collection and analysis for each method (Creswell et al., 2011). Thus, collection and analysis of quantitative data, and collection and analysis of qualitative data occurs.

The emphasis on rigor and integration is important to this definition of mixed methods research in order to separate it from mixed research. Researchers use mixed methods to provide a broader perspective and deeper understanding of our research questions and purposes (Greene et al., 1989). Mixed methods research is especially valuable when changes due to the intervention are not large enough to be detected quantitatively. Given how this research focuses on beekeeper knowledge and education, I expect certain changes in knowledge and self-efficacy to not be detectable by quantitative tools alone. That is not to say that quantitative or qualitative data are not enough on their own, however when examining broader questions such as beekeeper behavior and the impacts on honey bees, both types of data are needed to truly understand the bigger picture. Mixed methods research is not widespread in entomological research, as most researchers collect quantitative

data. However, under-explored fields or broader research questions benefit from the use of mixed methods research (Greene et al., 1989), hence the decision to use mixed methods research rather than a solely qualitative or quantitative approach.

References

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3nd ed.). SAGE Publications.

Creswell, J.W., Klassen, A.C., Plano Clark, V.L., & Smith, K.C. (2011). *Best practices for mixed methods research in the health sciences.* National Institute of Health.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a Conceptual Framework for Mixed-Method Evaluation Designs. *Educational Evaluation and Policy Analysis*, *11*(3), 255–274. https://doi.org/10.3102/01623737011003255.

Appendix C: Survey Questions

This survey was given to both program participants and non-program participants. Program participants took the survey twice, once before starting the program, and once after completing the program. Non-program participants completed this survey once.

Q1 What is your age (in years)?

_____

Q2 What is your gender?

- ○ Man
- ○ Woman
- ○ Nonbinary
- ○ Genderfluid
- ○ Other
- ○ Prefer not to answer

Q3 Choose one or more races that you consider yourself to be:

- [ ] White
- [ ] Black or African American
- [ ] Asian Indian
- [ ] Japanese
- [ ] Native Hawaiian or Pacific Islander
- [ ] Chinese
- [ ] Korean
- [ ] Guamanian or Chamorro
- [ ] Filipino
- [ ] Vietnamese
- [ ] Samoan
- [ ] Hispanic or Latinx
- [ ] Other _____

Q4 Your Primary Residence Location (County, State)

_____

Q5 Location of colonies (County, State)

_____

Q6 Select your highest level of education:

- ○ Some highschool
- ○ Highschool diploma/GED
- ○ Some college
- ○ Associate's degree
- ○ Bachelor's degree
- ○ Some graduate school
- ○ Professional degree
- ○ Graduate degree

Q7 What do you do for a living?

_____

Q8 How many years (including this one) have you been beekeeping?

_____

Q9 How would you classify yourself as a beekeeper?

- ○ Hobbyist (1-50 colonies)
- ○ Sideliner (51-500 colonies)
- ○ Commercial (501+ colonies)

Q10 What is your average yearly winter colony loss (% of colonies lost)? If you have not kept bees for at least one winter put N/A.

_____

Q11 What is your average yearly summer colony loss (% of colonies lost)? If you have not kept bees for at least one summer put N/A.

_____

Q12 Do you own any land?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Do you own any land? = Yes

If so, describe the type of land you own (e.g. purpose of land, type of plants/livestock, structures on land)

_____

_____

_____

_____

_____

Display This Question:

If Do you own any land? = Yes

If so, how many acres?

_____

Q13 Which of these conservation activities do you partake in? Select all that apply.

- ☐ Member of conservation organization
- ☐ Partake in habitat restoration project
- ☐ Grows non-food plants in a garden
- ☐ Master Gardener/naturalist
- ☐ Investment of time, money, or other resources in locally grown foods
- ☐ Participation in Eco-tourism
- ☐ Composting of waste (e.g. food scraps, yard waste)
- ☐ Adjustment of diet to reduce carbon footprint
- ☐ Engaging in environmental policy/lobbying
- ☐ Actions to reduce water usage in your home or landscape
- ☐ Actions to reduce fossil fuel and oil consumption
- ☐ Recycling
- ☐ Use of reusable products (e.g. glassware, coffee mugs, cloth grocery bags, stainless steel straws)

Display This Question:

If Which of these conservation activities do you partake in? Select all that apply. = Partake in habitat restoration project

Select one of the following that best describes your involvement with habitat restoration projects:

- ○ I help with the physical aspects of restoration (e.g. weed removal, mowing, planting of seeds)
- ○ I am a board member of an organization that partakes in restoration projects
- ○ I help with the design of the project (e.g. selecting land to restore, selecting plants to grow, designing land management plans)
- ○ I donate money to restoration projects

Q14List five plants that need pollination

_____

_____

_____

_____

_____

Q15 Is there anything you already are doing to help pollinators? List up to 4 actions.

_____

_____

_____

_____

_____

Q16 What are other actions (that you are not currently doing) that you could take to help pollinators? List up to 4 actions.

_____

_____

_____

_____

_____

Q17 Do you know of any policies or laws that involve pollinators? If so, please list them.

_____

_____

_____

_____

_____

Q18 Which of the insect choices listed below are considered important plant pollinators?

- [ ] Bees
- [ ] Beetles
- [ ] Butterflies
- [ ] Flies
- [ ] Wasps
- [ ] Cockroaches
- [ ] Robots
- [ ] Mantids

Q19 Which of the following best describes how you think of honey bees? As:

- ○ Wild Animals
- ○ Pets
- ○ Livestock
- ○ Other, explain: _____

Q20 Where do you get your information regarding bee health? Select all that apply.

- ☐ Web Forums
- ☐ Blogs
- ☐ Trade Shows
- ☐ Videos
- ☐ Academic Research Journals
- ☐ Magazines
- ☐ Books
- ☐ Extension Services
- ☐ Other Beekeepers
- ☐ Researchers
- ☐ Other, explain: _____

Q21 How do you tell if a landscape is good for keeping bees? List them below.

_____

_____

_____

_____

_____

Q22 In which way were you influenced to become a beekeeper?

- ○ Family member or partner
- ○ Through a friend/acquaintance
- ○ After learning about the plight of bees
- ○ After learning how bees will help me

Q23 Are you the primary beekeeper?

- ○ Yes
- ○ No

Display This Question:

If Are you the primary beekeeper? = No

If you are not, who is?

_____

Q24 During the growing season (when bees are actively foraging) how often do you inspect your hives?

- ○ More than once a week
- ○ Once a week
- ○ Every two weeks
- ○ Once a month
- ○ Less than once a month
- ○ Never

Q25 In as much detail as possible, describe what you look for when you inspect your hives.

_____

_____

_____

_____

_____

Q26 How confident are you that you know what plants your bees are foraging on throughout the year?

- ○ Very confident
- ○ Somewhat confident
- ○ Somewhat not confident
- ○ Not confident

Q27 List the names of the plants that your honey bees forage on for pollen or nectar for each season throughout the year.

_____

_____

_____

_____

_____

Q28 In a typical year, which of these problems do you encounter when beekeeping? Select all that apply.

- [ ] Bacterial Disease
- [ ] Viruses
- [ ] Varroa
- [ ] Ectoparasites
- [ ] Small Hive Beetle
- [ ] Tracheal Mite
- [ ] Fungal infections
- [ ] Queen issues
- [ ] Lack of forage during certain times of year
- [ ] Diversity of nectar or pollen bearing plants
- [ ] Herbicides
- [ ] Fungicides
- [ ] Pesticides
- [ ] Long-term erratic weather patterns
- [ ] Poor Management
- [ ] Inclement weather incidents

Q29 Which of the problems you selected above is most important to you? Why?

_____

_____

_____

_____

_____

Q30 How have you addressed this problem?

_____

_____

_____

_____

_____

On a scale of absolutely uncertain to absolutely certain, rate your degree of certainty for the following items.

Q31 How certain are you in your ability to:

	Absolutely uncertain	Somewhat uncertain	Moderately certain	Somewhat certain	Absolutely certain
Overwinter 70% of colonies	○	○	○	○	○
Appropriately treat for pests and/or diseases	○	○	○	○	○
Get rid of self-doubt after tough set-backs	○	○	○	○	○
Help others with their bee management	○	○	○	○	○
Relay reliable information to others regarding honey bees	○	○	○	○	○

Q32 How certain are you that you can identify:

	Absolutely uncertain	Somewhat uncertain	Moderately certain	Somewhat certain	Absolutely certain
Different types of honey bees (Queen, drone, worker)	○	○	○	○	○
Different stages of bee development (egg, larvae, pupae, adult)	○	○	○	○	○
Different pests/diseases that appear in my colonies	○	○	○	○	○
When to appropriately address my colony's resource needs	○	○	○	○	○

Q33 Compared to other beekeepers, how knowledgeable are you regarding:

	Less knowledgeable	Same level of knowledge	More knowledgeable
Wild pollinators	○	○	○
Honey bee biology	○	○	○
Honey bee management	○	○	○
Landscape management for honey bees	○	○	○

Q34 When beekeeping I feel:

	Does not describe my feelings	Slightly describes my feelings	Moderately describes my feelings	Mostly describes my feelings	Completely describes my feelings
Confident	○	○	○	○	○
Calm	○	○	○	○	○
Fearful	○	○	○	○	○
Proud	○	○	○	○	○

Appendix D: Hive Scoring Sheet

EARLY Season Langstroth (March /April)
5 = 12+frames of bees (16+medium frames)
4 = 7-11 frames (10-15)
3 = 5-6 frames (6-9)
2 = 3-4 frames (4-5)
1 = <2 frames (<3)

MID Season Langstroth (May - August)
5 = 16+ frames of bees (21+ medium frames)
4 = 13-15 frames (16-20)
3 = 8-12 frames (11-15)
2 = 4-7 frames (5-10)
1 = <4 frames (<5)

LATE Season Langstroth (September – October)
5 = 20+ frames (27+ medium frames)
4 = 15-20 frames (20-26)
3 = 13-14 frames (16-19)
2 = 8-12 frames (11-15)
1 = <8 frames (<10)

Lower score for:
No eggs = -0.25 (Not considered for October)
Poor brood pattern = -0.5
Fair brood pattern = -0.25
No to low resources (pollen) = -0.25
Low pollen diversity = -0.25
Disease/mite loads
- Low varroa = 0
- Medium varroa = -0.25
- High varroa = -0.5
- SHB = -0.25
- DWV = -0.5
- WM = -0.25
- CB = -0.25

Increase score for (only if it starts at <5):
Good brood pattern = +0.25
Eggs = +0.25
Lots of pollen = +0.25

Appendix E: Pre- and Post-Participation Interview Questions

Given prior to participation in the program and at the end of their participation to program participants. Also given once to select non-program participants. Questions marked with **POST** were only asked in post-participation interviews.

1. What do you consider honey bees?
    a. Wild animals
    b. Pets
    c. Livestock
    d. Other, explain:
2. How does an apple tree produce an apple?
    a. You mentioned pollination. Can you describe that process? OR Some people say that pollination is needed for an apple tree to make an apple. Do you think it is?
3. Can you list some pollinators?
    a. You mentioned honey bees, can you tell me more about Bumble bees and pollination? OR Some people think bees are important to pollination, can you tell me more about Bumble bees and pollination?
    Can you tell me more about Mason bees and pollination?
    Can you tell me more about Sweat bees and pollination?
    Can you tell me more about Orchard bees and pollination?

4. If you only had enough resources to conserve one group of bees (honey bees, bumble bees, mason bees, sweat bees, or orchard bees) in the United States, which group would you conserve and why?

5. Pick the best placement for honey bees on this plot of land (Landscape Map Question; See **Appendix G**)

6. How do you tell if an area is good for bees? What are signs that an area is good for bees?

7. In some instances you, or someone you know, may need to use pesticides (e.g. insecticides, herbicides, fungicides). What would you do to mitigate the risk of bees being exposed to pesticides, if you need to use them?

8. Can you tell me any factors that you think impact bee health?

9. What do you think is the most important factor impacting honey bee health? Why?

10. What are problems that you are concerned about in regards to your bees?

11. How did you get interested in beekeeping? Why did you decide to start keeping bees? How did you know that you were comfortable enough to keep bees? Describe those experiences to me.

12. Describe what you look for when assessing honey bee health.

13. Describe how you make management decisions regarding the health of your honey bees.

14. Where do you obtain your bee information?
    a. Books? Research Journals? Social Media? Mentors? Why?

15. Where are you going to obtain future information?
    a. Same resources? Different resources? From the same place, but perhaps different people?

Prompt with "change in pace"
16. In your own words, describe a good collaborative relationship.

17. What do you think needs to happen for there to be a good collaborative relationship between a beekeeper and landowner?

18. **POST** Are you working with a landowner?
    a. In your relationship with the landowner do you see any of these traits?
    b. Overall, how would you describe your relationship with the landowner?
    c. Would you call it a good relationship for your needs?

19. Are you a part of any beekeeping communities?
    a. What type of community? (Online, association, small group of friends)
    b. Can you describe your experiences with this group?
    c. Do you know the gender ratio of this group? Does this ratio matter to you?

20. **POST** Describe what it is like to be a woman beekeeper. Do you face any disadvantages as a women beekeeper? Any advantages to being a women beekeeper? Do you think any of these experiences are unique to you?

21.**POST** Do you think that this program and relationship would have been different for you in being partnered with a man? Why?

22. Was this program useful for you?
    a. Why? What worked? What didn't work well for you?

Appendix F: Follow-up Interview Questions

1. Can you list some nouns with which you closely identify?
    For example: I am an aunt, because I have two nephews whom I care for very deeply and I regularly take time to video chat them.

2. These nouns you used to describe yourself, do these play a role in you being a beekeeper?

3. How is your beekeeping going to change after being involved in this program?

4. Do you think your beekeeping experiences are unique to you?
a. Do any of these experiences compete with each other? Are any of your experiences in conflict with each other?
b. With whom do you share these experiences?

5. How do you tell if an area is good for bees?

6. What is the biggest impact this program had on you?

Appendix G: Landscape Map Question Protocol

Methods for Designing the Protocol

For this question, beekeepers were presented with a series of maps and scenarios. Each map has the same four quadrants, but the beekeepers received a new map for each scenario.

I began crafting the maps by looking at various rural areas in the state of Nebraska on Google Maps. Three areas were selected that presented different challenges to beekeepers; proximity to crop land, lack of water, proximity to neighbors, etc. From there, I started creating the quadrants of the map. Each quadrant was initially hand drawn, and then copied on a computer. To highlight which quadrant we were working in for each scenario, I reduced the brightness of the quadrants that were not in use for the scenario.

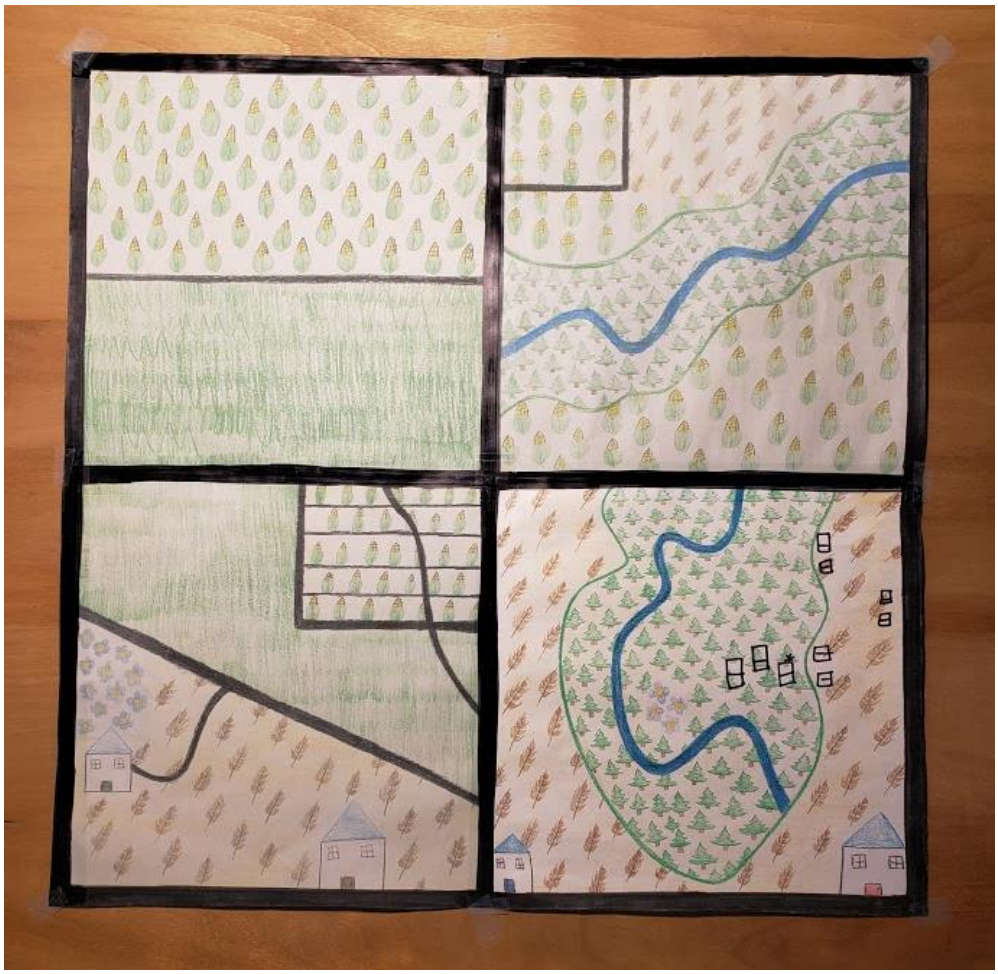
I added additional features to the quadrants that were not found on Google Maps to present different challenges to the beekeeper, such as removing forage, adding crop land, adding roads, and houses. Each map consists of four quadrants. To fill out the third quadrant, I gave beekeepers an empty quadrant and asked them to design a landscape for bees in the first part of the question. Photos below demonstrate how a beekeeper may have drawn on the map to answer this question. These maps were used during a pilot interview, not by a research participant.

Map Question Prompts

5. Pick the best placement for honey bees on this plot of land.
    1. Now I'm going to present you with a map. You are allowed to place a small apiary (8-10) hives anywhere within this plot of land. Some general things about this land: each quadrant is 1 mile by 1 mile. Winds usually comes through, going from west to east. No farmer uses crop dusters. Feel free to ask as many or as few questions will considering your placement.
        Other information if asked:
            All land is the same level
            They own the appropriate vehicle for traversing the landscape. (e.g. there is no issue regarding accessibility)
            Wheat is only irrigated in spring and winter
            They do have to consider cost and labor of putting in flowers/altering
            landscape (make alterations within reason)
    2. Present Quadrant III (picture below) by itself (not connected to other quadrants). Give participant marker and tell them to place a beehive on this land and design a landscape for the bees. Corn requires conventional methods of agriculture.

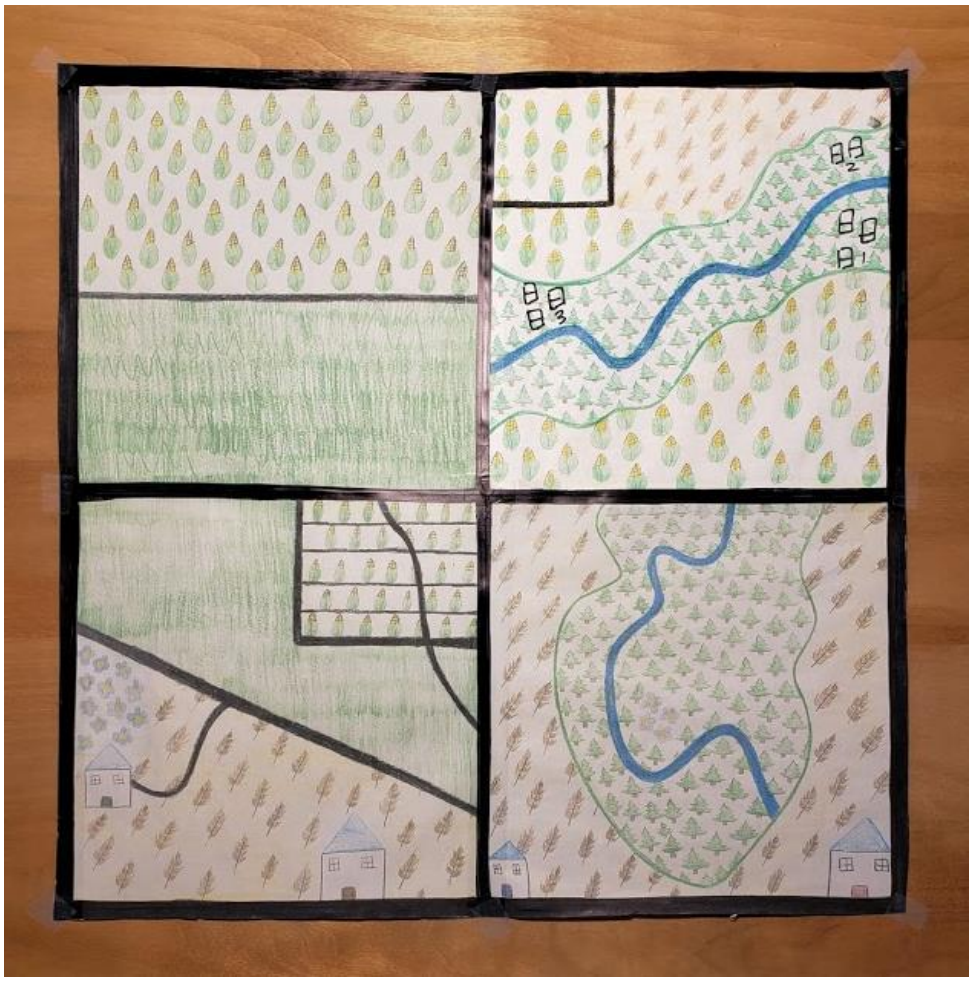
3. Give them scenario 1 (Quadrant 1).

Scenario: You and your significant other live in the house with the red door by yourselves, surrounded by wheat to the east and west. Your neighbors live in the house with the blue door with their three children ages 2, 6, and 9. Often times you look outside and see the children playing with their friends, but they usually stay close to their house. There is a forest to the northwest of your house, which you often hike through on Saturdays. Sometimes you even see people kayaking down the river. You have permission to place hives anywhere on this land. Where would you place your hives? Why? What considerations are you making?



4. Scenario 2 (quadrant II; pictured below)

A farmer has asked you to move some hives onto their land. You accept, as you live close by in the house with the red door. Not many people venture into the forested area that cuts through the farmers land, as it is private property. However, the farmer has cut some paths in the forest that you are allowed to walk on. This farmer employs conventional methods of agriculture, and their field continues going north of the map, which is where they live. You have permission to place hives anywhere on this land. Where would you place your hives? Why? What considerations are you making?



5. Scenario 3 (quadrant IV; pictured below)

You now live alone in the house with the green door (house 1). You often tend to your flower garden outside, where you rarely spray any pesticides. Your neighbors live in the house with the brown door. They are a young couple in their late 20's who recently moved in. A family with three kids (ages 2, 6, and 9) lives in the house with the blue door. The house is surrounded by wheat fields, with the exception of a small field of corn maintained by your neighbors with the brown door. They do not use pesticides in their growing of corn. You have permission to place hives anywhere on this land. Where would you place your hives? Why? What considerations are you making? Would you alter anything about the landscape for your hives?

Appendix H: Informed Consent Form

Protocol Directors: Bridget Gross

Protocol Title: "Women in Beekeeping"

Description: The purpose of this project is to increase profitability and environmental sustainability of beekeeping and farming through a collaborative approach. Small-scale women beekeepers and women landowners will be asked to discuss their knowledge regarding ways to support honey bees, other pollinators, and the overall agroecosystem on land. By understanding what women beekeepers and landowners know, we can better understand how education leads to, or does not lead to, behavioral changes. Some beekeepers and landowners may co-locate honey bees on the landowner's property. Measurements regarding crop and bee health will be taken to examine any potential benefits of the co-location of bees on the property. In doing so, we can better understand the benefits, or lack thereof, of co-location. You are invited to participate if you are a female landowner or beekeeper who is interested in contributing to this knowledge base.

Procedures: You will be asked closed- and open-ended questions about pollinators, conservation practices, agroecosystems, and bee health. You will also be asked to answer limited demographic questions. This interview will be completed either in person, or over the phone. Providing this information is completely voluntary. This interview will be recorded with your permission. After the interview, the recording will be transcribed. Only the research team will have access to your interview. You will be asked to complete two interviews.

Confidentiality and anonymity: Your identity will be known to the interviewer, and a pseudonym will be assigned to your interview responses for use in data analysis once the interview is transcribed. The results of this research may be presented as part of scientific or professional meetings, or presentations. Responses from your interview that are used in such venues will not contain any link to your personal identity. No information from the interview that identifies you to the research will be published. This interview was developed and implemented using Qualtrics Survey Software. The privacy policy of Qualtrics can be found on their website at: https://www.qualtrics.com/privacy-statement. All responses provided in the survey will be kept confidential on secure servers with password protected devices. All of your responses will be destroyed 2 years after completion of this study.

Time Involvement: This interview is expected to take approximately 45 minutes.

Risks: There are no foreseeable risks associated with this interview. Additionally, you will not be asked questions of a sensitive nature.

Benefits: The benefits which may reasonably be expected to result from this study are indirect: you may gain new insights into your methods bee or land management. The findings of this research will be shared with the scientific community to better

our understanding of the subject and make informed decisions to help protect and conserve pollinators and agroecosystems. Participation in this study advances our understanding in the fields of science, education, conservation and entomology.

Incentive: There is no monetary compensation for participating in this study.

Participants Rights: Your participation is voluntary. You have the right to refuse to answer particular questions. You have the right to withdraw your consent or discontinue participation at any time without harming your relationship with the researcher or University of Nebraska-Lincoln. You will not in any way receive a penalty or loss of benefits to which you are otherwise entitled.

The Opportunity to Ask Questions: If you have any questions or concerns please contact Bridget Gross at bgross3@huskers.unl.edu or Dr. Doug Golick at dgolick2@unl.edu. If you wish to speak with someone else, please call the Research Compliance Services office at (402) 472-6965 or at irb@unl.edu.

The University of Nebraska-Lincoln wants to know about your research experience. This 14 question, multiple-choice survey is anonymous; however, you can provide your contact information if you want someone to follow-up with you. This survey should be completed after your participation in this research. Please complete this optional online survey at: http://bit.ly/UNLresearchfeedback.

Consent: You are voluntarily making a decision whether or not to participate in this research study. By signing your name, you certify that you have decided to participate having read and understood the information presented, and that you agree that you are at least 19 years old or older. For future reference, print or save a copy of this consent form for your records.

Signature: _____

Printed Name: _____

Date:_____